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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 322.*)

Forthcoming Events.

MAY 11-15.

Society of Chemical Industry:—Chemical Industry Conference

MAY 15.

The Institution of Welding Engineers:—Ordinary meeting in London. P. L. Roberts will read a Paper on "Standardisation of Welding."

MAY 16.

Faraday Society:—Annual general meeting at Burlington House, London. Presidential address by Professor C. H. Desch, on "Diffusion in Solids."

MAY 22-24.

Institution of Mining and Metallurgy:—Special meeting in Cornwall.

MAY 26.

North of England Institute of Mining and Mechanical Engineers:—Ordinary meeting at Newcastle-on-Tyne. "The Use of Carbon Monoxide Masks in Mines," Paper by Richard White.

JUNE 9.

Institute of British Foundrymen.

West Riding of Yorkshire Branch:—Summer outing.

The Literature of Cast Iron.

The story is told of a young lady who went to the library for the History of England, and was asked which one. "Oh," she said in surprise, "are there several?" Had her subject been the metallurgy of cast iron, her surprise would until a short time ago have been justified, for until the recent publication of Mr. Hurst's book, the only work in English exclusively devoted to the subject was Dr. Hatfield's "Cast Iron in the Light of Recent Research." The publication this year of the third edition—a review of which appears elsewhere in this issue—is a tribute both to the book itself and to the growing interest in the metallurgical aspects of this long-neglected material. The two books, of course, are in no sense competitors, for while both appeal to students, it is to students of somewhat differing types.

The first edition of Dr. Hatfield's book was published before the war, and this was somewhat hastily brought up to date in 1918 to meet the requirements of that active period. It is matter for gratification to all interested in the subject that a third, and what might now be called a definitive, edition has been called for—we say definitive because, if and when further revision is required, a complete replanning of the book may well be demanded. The ferment of development in cast iron matters that is going on in various parts of the world, and in particular the work of the Cast Iron Research Association, is bound to necessitate the inclusion of much new matter, and may even require a new method of approach to the subject.

One of the most striking signs of the revived attention given to the metallurgy of cast iron is the intense interest that practical men are showing in the subject. It has been noticed that it is easier to get together a large meeting of such men to hear about a subject which would a few years ago have been regarded as academic, than to consider matters of more direct practical interest.

We are anxious that this interest should continue and increase, and we feel that it can be considerably fostered by authoritative lectures and talks in which the more abstruse matters are dealt with in a simple and easily understandable way. We suggest further that the Cast Iron Research Association might serve a useful purpose in preparing an annual review of progress in cast iron in which the year's development in this country, in Germany, France, Belgium, Italy and America, might be summed up in a judicial and impartial fashion, and in proper perspective. Thus contributions of permanent value might be separated from the ephemeral, and really disinterested work distinguished from that inspired by purely commercial motives and lacking independent sponsorship.

In the meantime, Dr. Hatfield can view with pride the share his book has had in spreading knowledge about the material we have to deal with, since the dissemination of existing knowledge must necessarily precede the acquisition of more.

Co-operation Desired.

It is axiomatic that a problem clearly stated is half solved, and one of the most pressing problems of the foundry industry is the related question of apprentice recruitment and training. Before any hope can be held out of finding a definite solution it is essential to know exactly what facilities exist or can be created for the technical instruction not only of the neophyte operative but also the executive. That they do exist is obvious from the fact that Britain possesses some of the foremost foundry metallurgists and engineers in the world. In order to make a practical contribution to the subject we have enlisted the co-operation of our colleague, Mr. Percy Fox-Allin, whose services are at the disposal of every educational authority of Great Britain. He is visiting each centre in turn, and has already received promises of the sympathetic co-operation of Universities of Birmingham, Manchester, Sheffield, Liverpool, Wales, the technical colleges at Birmingham, Wednesbury, Manchester, Woolwich, Middlesbrough, Loughborough, and others. This list, however, is insufficient, as we are aware that foundry subjects are being taught in other centres, and we want still further co-operation. Glasgow, Falkirk, Mansfield, Darlington, the Sir John Cass Technical Institute, Chelsea, Borough, Leicester, are all doing something. No doubt there are many others, and it is our object to make this survey as complete as possible. To this end, we shall be pleased to receive offers of further co-operation. Finally, we wish to thank very sincerely Professors Desch, Hanson, Bannister, Thompson, Drs. F. Johnson and H. Hyman, Messrs. Rhead, Otto, Ingal, Schofield, and Tavernor for the kindly offers of sympathetic help in this matter.

XUM

Institute of British Foundrymen.

WEST YORKSHIRE BRANCH.

The annual meeting of the West Riding of Yorkshire Section of the Institute of British Foundrymen took place on April 28 at the Municipal Technical College, Bradford. The chair was occupied by the President (Mr. W. Parker, of Sheffield).

The Hon. Secretary (Mr. S. W. Wise, of Bradford), in his annual report and financial statement, showed that there was a balance in hand, after the year's working and payment of accounts due. Mr. Wise said it might sound rather hackneyed to report that they had reached the end of a very successful session, but the fact remained that the session really had been very successful and useful indeed. All the meetings arranged for on the syllabus had been held, and attendances of members had been very satisfactory, indicating a sustained interest. In addition to the two works' visits arranged on the programme—Messrs. David Brown & Sons (Huddersfield), Limited, and Messrs. Asquith, Limited, of Halifax—there had been extra visits to the works of the Leyland Motor Company and the Yorkshire Coal and Iron Company, and it was the intention of the Council to continue this policy of works' visits, of practical interest to foundrymen, during the forthcoming summer. The Branch was not, perhaps, making new members as rapidly as might be desired, but they were securing new members—and members of the right sort. The average attendance at meetings was over 50 per cent. of the membership, and there was strong evidence of a solid *bloc* of consistent and loyal interest and support by members who had the interests of the Institute thoroughly at heart. A new and very interesting feature of the year had been the establishment of a technical reference circulating library, and the Council of the Branch hoped this would be utilised by members to its full capacity. (Applause.)

The President, moving the adoption of the annual report, complimented the Branch on the success reported and the Secretary on the manner in which he had carried out his work during the session and prepared the summary of activities for the purposes of the report.

Mr. W. G. Thornton (Bradford) seconded the adoption of the report and balance-sheet, and the proposition was carried unanimously.

The election of officers resulted as follows:—President, Mr. W. G. Thornton (Bradford); Vice-Presidents, Messrs. H. Sayers (Leeds) and A. S. Worcester (Huddersfield); Hon. Secretary and Treasurer, Mr. S. W. Wise (Bradford); Members of Council, Messrs. J. W. Blair (York), H. Forrest (Bradford), W. Hird (Bingley), G. Nield (Leeds), W. H. Poole (Keighley), J. J. Watson (Huddersfield), J. Butterworth (Halifax), R. W. Welford (Bradford), and C. H. Wass (Leeds), the latter filling the place of Mr. Worcester, the new Junior Vice-President, and due to retire at the date at which Mr. Worcester would ordinarily have retired. Messrs. Welford and Hird were re-elected Hon. Auditors; Mr. Worcester was appointed Branch Delegate to the General Council of the Institute; Messrs. Forrest and Hird were appointed Registrars; and Mr. Forrest was confirmed in the appointment (made temporarily since the formation of the library) as Librarian to the Branch.

The Hon. Secretary drew special attention to the arrangements made for the annual summer excursion of the Branch—a pleasure excursion, to which it was hoped members would bring their wives. The function would be on Saturday afternoon, June 9, being a motor drive to Fountains Abbey and Studley Royal. The cost would be 6s. 6d. per head for the journey, and 2s. 9d. per head for tea at Studley Royal. The party would be back in Bradford by 9 p.m. in order that members might catch their trains to other towns.

WALES AND MONMOUTH BRANCH.

The annual general meeting of the Wales and Monmouth Branch was held at the University of Wales, Newport Road, Cardiff, on April 28, 1928, where an inspection of the laboratories had taken place.

The party having retired to one of the lecture rooms, Professor Reed expressed the pleasure it had been to him to meet the Branch. He said that he wished the young members especially to remember there was a theoretical as well as practical side to the foundry, and referred to the old days when John Wilkinson did so much for the advancement of the trade, remarking that his bi-centenary would be celebrated this year. After this very little of importance occurred for a number of years. Each foundry got to know the particular mixture most suitable for its own particular type of work, but they did not know the why and wherefor of the mixture. It was only within the last fifty years that foundries had any inner knowledge. Professor Turner had been a pioneer, and had brought out a Paper on silicon, which was a most important element in foundry work. This was the first real knowledge many possessed, but to-day the knowledge was pretty general that one should not attempt to use a pig-iron high in silicon for blackheart or whiteheart castings or for a pearlitic structure. Reference was also made to the fact that it was not advisable to use nickel with high-silicon pig-irons.

Professor Reed pointed out that a theoretical knowledge was bound up with a practical knowledge, and said that forty years ago aluminium was looked upon as a rare metal, but to-day every mortal thing could be cast in this metal. Again, there was magnesium. This had been looked upon as rare and expensive. Research had resulted in an alloy being formed and so on until we came to present day, and found that Mr. Jones had been working upon an alloy and experimenting with Duralumin with the results as seen. Castings had been made which at first had large blowholes, but now it was possible to make them as near perfect as possible. The University has started a Saturday morning class for the study of the microscopical structure of various metals, and Professor Reed expressed his ambition for an experimental foundry at the University before his time to retire came along. He added that it had been the intention of Mr. Harrison to give an address, but business in London had prevented his getting back in time to do this. Professor Reed hoped the younger members had seen how intimately science and practice were wrapped up together.

Mr. Hird (Branch-President) said that it gave him great pleasure to propose a very hearty vote of thanks to Professor Reed and his colleagues for spending so much of their valuable time in showing the members over the buildings. Professor Reed had, said Mr. Hird, referred to Professor Turner, who had now retired and whose work was so much appreciated by the Institute of British Foundrymen that a testimonial had been given. If the foundry Professor Reed had referred to came into being the apprentices in Cardiff would be most fortunate.

Mr. McClelland, in seconding the vote of thanks, said he need not enlarge upon what had already been said, but would like to say how grateful he was for the encouragement the University had extended to him and the help they had given in providing something of real interest for the members. Mr. Jones had been most helpful, and had promised to give a lecture during the next session.

The vote of thanks was carried with acclamation, and Mr. Jones said he would only thank the members for their reception of same and the amount of interest taken in the tour. The University would like members to be more interested still. The Saturday morning classes were held for the man in the works, and it was their desire to teach the theoretical side of the foundry.

The following officers were elected for the ensuing twelve months:—

Branch-President.—Mr. R. G. Williams, of Barry.

Senior Vice-President.—Mr. W. S. Kinsman, of Cardiff.

Junior Vice-President.—Mr. R. J. Richardson, of Pontypridd.

Hon. Secretary.—Mr. J. J. McClelland, of Whitchurch.

The following members were elected to serve on the Branch Council:—Messrs. Coles, Domville, Hares and Richards.

A vote of thanks was passed to the retiring officers, and the warmest thanks of the meeting extended to the Hon. Secretary for his valuable services and unflagging interest in the work of the Branch.

MIDDLESBROUGH BRANCH.

The annual meeting of the Middlesbrough Branch was held at the Cleveland Technical Institute on April 27, Mr. F. P. Wilson presiding over a good attendance.

"We have come to the end of our second session, and as I am about to retire from the office of President," said Mr. Wilson, "I think we can look back on the history of the Branch during the past two years with some satisfaction. We are not a large Branch, but I think we have a great deal of interest among our members in the work and the objects of the Branch. We have had useful Papers from time to time, and what we have aimed at and succeeded in achieving has been a friendly and sociable spirit in all our meetings."

Their conversational discussions, Mr. Wilson explained had been of exceptional value. The Branch as a whole hoped that they would be able to create more interest among its members by visits to local works. During the past session they had paid a visit to one foundry, and many members seized the opportunity to gain knowledge. "I hope the Branch will hang together and go on increasing in usefulness. There is no question that we can learn a great deal from each other. Every foundry is worked on different lines—almost every shop is working on some different product—and I think we have all something different to offer and receive from each other."

Referring to the fact that during the past session the Branch had been prevented from hearing one Paper which was intended to be read, Mr. Wilson said it was regrettable that some higher authority prevented its realisation through an early Victorian idea that things should be kept locked-up. It was a rare happening, commented the President, and was not likely to occur again. (Applause.)

The minutes of the last annual meeting having been read and confirmed, Mr. Bashford, the Hon. Treasurer, presented the balance-sheet, which revealed a credit balance of over £13, which was considered satisfactory, and the balance-sheet was adopted unanimously.

Mr. N. D. Ridsdale, the Hon. Secretary, said the last session had not shown any appreciable growth in membership. One subscribing firm had resigned and one had joined. The Branch's total membership was 69, including 26 members, 29 associate members, 9 associates, and 5 subscribing firms. Stressing the need for good attendances at the lectures, Mr. Ridsdale said it was difficult to get the services of lecturers to give Papers when the membership of a Branch was only small. The Branch Council had been instrumental in starting local evening classes, 50 students having been enrolled, and the Stockton-on-Tees Education Committee had since got into touch with the Branch, and was likely to start classes in its area.

The report was adopted, and a vote of thanks was accorded to the retiring officials.

Mr. F. P. Wilson stated that the Council had had under consideration the question of the officials for the current year, and made the following recommendations:—President, Mr. S. Toy; Senior Vice-President, Mr. R. Ritchie; Junior Vice-President, Mr. J. D. Smith; Hon. Secretary, Mr. N. D. Ridsdale; and Hon. Treasurer, Mr. Bashford. Mr. Wilson added that Mr. Toy was practically one of the founders of the Branch, and had been greatly interested in its work since inception. On behalf of the Council he moved the adoption of the recommendations, and they were approved unanimously.

Accepting the office of President, Mr. Toy said he was conscious of the honour they had conferred upon him, and he hoped he would be able to follow the example set the Branch by Mr. Wilson, who had helped them through the most difficult part of their existence.

The election of members of the Council resulted in the appointment of Messrs. Hackwood, Scholes and Woolley.

The Institute of Metals.

MAY LECTURE ON CRYSTALS.

The annual May lecture was delivered before the Institute of Metals in London on May 8 by Professor C. H. Desch, F.R.S., on "The Chemical Properties of Crystals," Dr. W. Rosenhain, F.R.S., president, in the chair.

After referring to the light thrown on the mechanical and physical properties of crystals by modern ideas as to the atomic structure of matter and the internal structure of the atom, the lecturer discussed the various ways in which atoms may be held together in a crystal, by the simple exchange or sharing of electrons, or by residual forces. In rock salt the molecule had disappeared, but there were many substances which were built up of molecules in the solid as well as in the liquid state. In a few simple cases it had been found possible to calculate the forces of attraction in a particular face of a crystal, and in that way the differing chemical properties of different faces might be explained. Such differences accounted for the varying habit of crystals of the same substance grown under different conditions.

When a metal was attacked by an acid, the surface was not dissolved uniformly, but distinct "etch-figures" were produced, and the shape of those must be intimately related to the internal structure of the metal crystals. The figures might vary in the most curious way when the solvent was changed, and that was shown most clearly by large single crystals of copper.

The compounds of metals with one another have puzzled chemists, as they do not follow the ordinary rules of valency, and have many anomalous properties. The modern view of the constitution of the atom made it possible to explain them, and the relations which have been found between the forces of cohesion and of chemical affinity made it likely that there was a gradual transition from the simplest solid compounds, such as salts, through intermetallic and other compounds, to solid solutions which were regarded as mixtures.

The chemical properties of crystals were most easily illustrated by substances which did not consist of closely packed atoms, but had an open structure, such as graphite. Looseness of structure was also important for diffusion in solids, on which many technical processes depended.

LIVERPOOL CONFERENCE.

The Council of the Institute of Metals has just issued a preliminary programme of the four-day annual autumn meeting of the Institute, which is to be held this year in Liverpool. In the course of the twenty years of the Institute's existence most provincial centres and many foreign cities have been visited, but this is the first occasion on which Liverpool has received the members of this world-famed body of metallurgists and engineers. The proceedings will begin on September 4 with a lecture on "Non-Ferrous Metals in the Shipping Industry," by Mr. F. G. Martin, B.Sc. The mornings of September 5 and 6 will be devoted to the reading and discussion of Papers, and the afternoons to visiting works of interest in the neighbourhood, the Gladstone Dock and a large liner. On the evening of September 6 there will be a reception at the Town Hall by the Lord Mayor (Miss Margaret Beavan, J.P.). The meeting will conclude on September 7 with an all-day motor trip to North Wales, during the course of which it is expected that an electric power station and aluminium works will be visited.

In addition to the main reception committee (presided over by Professor C. O. Bannister, of Liverpool University) that is charged with the duty of making the general arrangements, ladies' reception committee has been appointed for the entertainment of lady visitors. Ladies and members will be entertained to luncheon and dinner by the reception committee.

Full particulars of the meeting, and membership application forms, can be obtained from the Honorary Local Secretary, Mr. H. F. Richards, B.Sc., 42, Bedford Street, Liverpool, or from the Secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

Book Review.

Cast Iron in the Light of Recent Research. By W. H. Hatfield, D.Met. 3rd edition, revised and enlarged. Published by Chas. Griffin & Company, Limited, 42, Drury Lane, London, W.C.2. Price 16s. net.

Dr. Hatfield's work is well known to students of cast iron metallurgy. It is confined strictly to the subject with which it is directly concerned, the first six chapters dealing with the iron-carbon alloys and with cast iron from the point of view of the equilibrium diagram, followed by a consideration of the influence of specific elements, silicon, phosphorus, manganese, sulphur, and others. Physical properties are then discussed, together with such matters as the influence of casting temperature, shrinkage and contraction, annealing and growth on heating. The next five chapters deal with whiteheart and blackheart malleable, and the concluding chapters which follow are concerned with mechanical properties and slags, with a new final chapter on X-ray examination of materials.

In reviewing a revised and enlarged edition it is the changes and additions that call primarily for attention. These include fifty pages of new matter, with a dozen additional illustrations. An examination of this shows that the author has followed recent work closely, and two points deserve to be emphasised in this connection. In the first place, every really important new piece of work is covered, even if only by a recommendation to the student to consult the original; secondly, the author is scrupulously impartial in dealing with conclusions drawn by other authorities from which we know him to differ.

Some people might consider that from the student's point of view a certain amount of matter which is now mainly of historical interest might well have been omitted. We believe, however, that the author has been wise in retaining his original method of treatment, because it is very useful to the student to see the way in which the subject developed. It affords an insight into the difficulties of the early experimenters which not only demands admiration for the work they accomplished, but which often provides the inspiration for future work. In too many text-books the treatment is conventionalised to a point at which the completed whole seems to the student to have been provided ready-made by a special dispensation of Providence.

In the Preface, Dr. Hatfield pays a compliment to the work of the Cast Iron Research Association which might well have proved embarrassing to an officer of that organisation charged with the task of reviewing it. Fortunately, however, the present writer's opinion of the book is well known; it is indeed, and has always been, in the nature of gospel to the cast-iron metallurgist. Among British workers whose contributions are dealt with, and whose work was first published by or through the Cast Iron Research Association, we find the names of Fletcher, Becker, Hanson, Taylor, Northcott and Partridge.

J. G. P.

SOME INTERESTING FIGURES concerning iron and steel furnaces were given by Mr. C. Hubert Plant in a lecture on "The Manufacture of Structural Steel," before the Junior Institution of Engineers, on April 27. Mr. Plant said that there was one blast-furnace in existence which produced 700 tons of pig-iron per day, but there were very few above a capacity of 500 tons per day, and in this country the average size was 500 to 700 tons per week. Mr. Plant described a modern blast-furnace in which the charging operations were carried out electrically from the ground, so that it was unnecessary for men to work at the top. He also mentioned a continuous rolling mill used for rolling rails, which was operated electrically under the control of one man, who could manipulate the ingot through the first mill for the proper number of passes, send the steel on to the next mill for further rolling, and then through a third mill for the final rolling of the section. The annual dinner of the Institution was held on April 26, the president (Sir Murdoch MacDonald, K.C.M.G., M.P.) being in the chair. Amongst the guests were Mr. E. S. C. Trench, C.B.E., president of the Institution of Civil Engineers, Lt.-Col. J. T. C. Moore-Brabazon, M.P., Rt. Hon. Ian MacPherson, K.C., M.P., Brig.-General Magnus Howat, C.B.E., Mr. W. E. W. Millington, Mr. G. J. Shave, Mr. F. W. Bridges.

Random Shots.

I have been reflecting at some length on this business of the Englishman's reluctance to attend conferences abroad, and I have come to the conclusion that the Channel has a great deal to do with it. No, I don't mean that our bulldog breed is afraid of being sea-sick; sea-sickness is not nice, whether it be your own or other people's, but it has never yet deterred the would-be traveller, any more than it deterred Nelson from following the sea.

* * *

Nor is it altogether a case of the length of time, although all busy people will welcome the Southern Railway's promise of a speeding-up of the cross-channel service, and will await its fulfilment anxiously. It is rather the psychological effect of having to go by train, and boat, and train again, and so being reminded forcibly of the very real barrier that has to be surmounted. The journey from London to Paris, after all, is very little longer than that from London to Devon or Cornwall, which is regularly undertaken every summer by dozens of families—yet how infinitely more formidable it sounds to say that you are going to Paris on business than that you are taking the wife and children to Penzance for a fortnight! What is more, the man located in Paris or Berlin will think nothing of going to Prague or Constantinople if his business warrants it, because he has merely to get into a train and stay there!

* * *

The strange thing about it is that the English probably travel more for pleasure than any other nation in the world, except the Americans, and with them there are cases where, one suspects, duty plays a not inconsiderable share. The English visitors in any Continental centre of importance almost always outnumber the French, the Swiss, the Germans, the Italians. . . . Yet when it comes to business, we are the laggards—truly an odd phenomenon.

* * *

Cautionary Tales for Ironfounders.

(*With apologies to Mr. Hilaire Belloc.*)

Alonzo, who was bored with Sport.
The snag about Alonzo Cawte
Was taking no delight in sport.
His youth most studiously was spent—
O'er books his back was ever bent.
His mother proudly on him gazed;
His teachers every effort praised.
Only his father gently chid
The foolish boy who never hid
The painful and immoral fact
That he all shred of interest lacked
In dogs and horses, bat and ball;
Mere childish follies were they all.
And when it came to leaving school,
And plunging in the whirling pool
Of life, he swore he would not alter,
Nor from the path of virtue falter.
His father to the works conveyed him;
Apprenticed there, the talked dismayed him.
He found the foreman most unkind
Because he could not bring his mind
To take an interest in the Cup.
His mates, disgusted, gave him up.
Lonely, he sought another shop,
Hoping to make a longer stop:
But there the talk was all of cricket—
It seemed t'Alonzo downright wicked!
He tried a third—on greyhounds there
The talk was centred wet or fair.
Alonzo could not stand the strain;
His trouble soon brought on a pain.
He sickened, took to bed, and died—
His fond Mamma was sorely tried.
Now let this for a warning stand
To every young man in the land—
That if you care no whit for sport,
Success on earth will be but short.

MARKSMAN.

XUM

The Theoretical and Practical Training of the Foundry Apprentice.

By Percy Fox Allin
(Associate Editor of the Foundry Trade Journal.)

The future of the foundry is largely bound up with the apprentices of to-day; it is imperative, therefore, that we should explore every channel that will create interest in and impart knowledge to the foundrymen of to-morrow. We are afraid that it must be admitted that hitherto the foundry has not attracted the best type of lad. Admitting so much, there is obviously a greater need to impart knowledge to those upon whom the future of the industry must depend.

Although the foundry has always demanded manipulative skill and craftsmanship of a very high order, the efforts to foster the proper appreciation of these facts have always lacked organised support. The foundry has been equally backward in its appreciation of the value of machinery, and it is only during recent years that more advanced foundrymen have realised the necessity of advancing with other industries in this respect.

The day is past when the foundryman could be dubbed a "sand puncher," a hewer of wood and a drawer of water. The complicated work of to-day demands high technical ability, combined with practical experience, and there are very few foundries where this technical knowledge is, or indeed can be, imparted. Except to a very limited extent, no serious effort is made to train the apprentice in the works, too often he is regarded merely as a form of cheap labour. Specialisation has also been responsible to a great extent for the lack of training the apprentice receives.

Other facilities for this technical and practical training are only available to a limited extent. We have the Universities, Polytechnics and Technical Schools, but in very few instances is there any co-ordinated scheme specially arranged for foundry workers, whilst almost every other craft is well catered for.

Lack of Funds Deemed to be Responsible.

The lack of the necessary funds is no doubt directly responsible for this very undesirable condition. It is not the fault of the Universities concerned, they are not in a position adequately to finance the work of the metallurgical department, and this, combined with the lamentable apathy of the responsible Governmental Department, leaves our Universities to carry on the education of the metallurgical student with an overworked and for the most part underpaid staff, and a more or less skeleton apparatus. In the meantime we do not propose to discuss the policy of the Government grant to the student carrying an educational diploma, or the effect that such grant may have upon the teaching profession as a whole. In some quarters this grant is regarded as a move in the direction of reducing the Burnham Scale; that, however, is beside the present question.

The technical school is scarcely affected, and the elementary school is only entered as a last resort; it is almost invariably the secondary school which recruits the services of the student who has obtained the Government grant.

As we have already stated, we are not concerned with the policy of the grant, but assuming that policy has been carefully considered it is not unreasonable to expect the metallurgical student to be placed upon the same basis.

An Indefinite Status.

It may be that in our educational scheme the prospective foundryman has been more or less ignored because he has no definite status like the engineer or builder; in a word, no definite status of education has been fixed by the representative organisation of foundrymen, therefore any examinations the student may pass have little or no significance, having no recognised backing, they carry little weight. Whilst one would not wish to place too much stress on the possession of "paper" qualifications, they serve a useful purpose in affording some proof of work done.

Entrance by Examination.

In this direction the Institute of British Foundrymen might well consider the advisability of adopting a scheme similar to that supported by the Institutions of Mechanical and Electrical Engineers, *i.e.*, the granting of a certificate on completing a course of study and passing successfully the necessary examinations.

In regard to the syllabus for these examinations, the subjects to be covered would, of course, be decided by a committee appointed by the Institute of British Foundrymen. This would open out the subject and place it upon a basis which would ensure national recognition.

It would seem desirable to have preliminary, intermediate and final examinations, the final certificate being endorsed when subsequent examinations were passed bearing on the foundry. With due consideration being given to the practical ability of the recipient, the final certificate should entitle the owner to be recognised as a fully qualified foundryman.

We now come to the question, Can the practical and technical education of the foundry apprentice be carried out at our Technical Schools and Universities? This question can be answered with an unqualified affirmative, but we must reply with an equally positive negative to the question, Are the institutions referred to at present in a position to carry out those functions to the best advantage of the community?

We must differentiate between the functions of the technical school and the university. The objective of the first is the practical instruction of the student, whilst the function of the university is the teaching of the fundamental science of the industry; to adopt any other course at the university would be wholly impossible, and we are of opinion that it would be equally undesirable. Training in the foundry, supplemented by a course at the technical school, are almost inseparable in the education of the practical foundryman. Those, however, who will derive full benefit from a university training are in a small minority; failure to recognise this concrete fact has been responsible for a great deal of heart burning in the past.

At most of our Universities the instruction of the foundryman is treated as a trade subject and generally comes under the head of an Engineering Dept.; metallurgy, on the other hand, is usually, though not always, under the head of a chemical dept.

It is thus only possible with the limited means at present available to treat the foundry industry in a subsidiary manner, and generally very little co-ordination exists in teaching the various subjects necessary to become fully qualified.

The Professors at our various Universities are keenly alive to the limitations which poverty places upon their scope of operations, yet the sum of money involved is relatively very small. A Government grant of £50,000 would be sufficient completely to revolutionise the scope and possibilities of the Metallurgical Departments of the whole of the Universities in the United Kingdom. Foundry organisations should, and indeed must, be actively interested in pioneer work to this end, giving a definite lead to the fact that at least as much intelligence is necessary to carry on the traditions of the foundry as any other industry.

In subsequent issues we propose to deal with the Metallurgical Departments at our various Universities and Polytechnics, as showing the facilities which at present exist for the scientific and technical training of our future foundrymen.

Restrictions !

By "Onlooker."

Theoretically, in this country, we resent restrictions more than any other nation, but actually we put up with a good many, and almost grow to love them because they give us something to grumble about! Such limitations to our activity as are imposed by statute are usually plain enough to the eye, and if they are not, then one of our enterprising dailies gets busy with heavy type and startling headlines.

There are certain restrictions in business life which are just as necessary as rules in a game of cricket, and no right-minded person ever dreams of contesting their usefulness, for such limitations are imposed for the good of the majority in the world of trade. There are, however, other provisos met with in the commercial arena which press rather hardly on a minority of the weaker combatants and which certainly cannot be defended on the score of all-round utility.

Trade associations, of which we have many in this country, have proved themselves to be of great and permanent benefit to the industries for which they labour, but in their anxiety to maintain authority there appears to be a danger of insistence on a series of comparatively small matters which operate rather as pinpricks than as props. On the selling-side there are frequently rules which insist upon a premium for small lots, and from an accountancy point of view a rigidity in concessions relating to discount granted for payment within a prescribed period, and a clause in the rules which forbids payment by bill, are illustrative of the unbending attitude often adopted.

Such associations encourage the "outsider" in his activities, and in the instal trade there are a goodly number of firms, both manufacturers and merchants, who are carrying on very successfully by selling their goods at a fractional discount below the controlled price. Some of our associations, wiser than others, have brought elasticity into their code of regulations, and thereby made it possible for members to quote special prices when in competition with the foreigner or up against persistent cutting by "free lances," but if the trade association is to be saved from disruption such concessions must obviously be granted sparingly. From the consumer's point of view this outside competition is obviously all to the good, for it removes the risk of anything in the shape of a monopoly, but what about their chances when alternative avenues of purchasing are non-existent?

In the world of copper to-day, consumers find themselves faced with a monopoly which allows practically no alternative for the purchaser of electrolytic qualities, since only the barest trickle of "free" copper finds its way into this country. The elimination of the merchant must obviously have closed many channels of supply which were formerly open to manufacturers, and to all but a number of firms of almost world-wide renown in the non-ferrous trade, the terms of this selling organisation are "cash before delivery." Many of the irritating restrictions which were imposed in the early days of the American combine have been withdrawn, but a stiff premium is still demanded for small lots of 5 and 10 tons, and there is a daily tonnage limit which frequently places consumers in a difficult position in covering against sales.

Another sense in which restriction figures somewhat prominently in the metal world is on the production side of the picture, and although up to the present there has been a good deal more talk than action, the menace is ever present. Zinc smelters are credited with the intention to reduce output whenever the London price falls below £26, while in the case of copper, the North American mine output, if not actually restricted, is at any rate being carefully watched. In this connection copper users are certainly very much in a cleft stick, for owing to the methods employed by the association they have no alternative but to place orders for "controlled" metal, and hedging transactions in the standard market are virtually a thing of the past since stocks fell to such a dangerously low limit.

Of all restriction evils from which this country is suffering, perhaps the most flagrant—in the sense that it might well be avoided—is the monopoly of leadership exercised by some of the older men in our industries. There are, of course, outstanding examples of brilliant men controlling large combines, who have achieved success merely by commonsense delegation of their authority, but the "one man show," the place where only one opinion is allowed to be voiced or followed, is an example of restriction in its very worst and most enervating form.

Certain rules and regulations are necessary, but officialism run mad is a dead weight on business progress and prosperity. Let us, in the metal trade at any rate, see to it that whoever else may err, our record shall be blameless.

XUM

Scottish Branch Discusses Local Moulding Sands.*

Mr. Primrose congratulated Mr. Hudson on presenting one of the finest Papers he had ever heard in that hall, and raised some laughter by twitting the lecturer on his classification of Belfast sand as a Scottish moulding sand. Mr. Hudson had stated that sands dried by heat were not so good unless they were allowed to lie for ten hours. That was surprising to him, for the practice in some American foundries now was to convey the sand by belt from the castings shake-out, dry, and add necessary clay bond, re-mill, and return to moulding machine by a continuous process. Two weeks ago, when he was on the Continent, he saw two foundries where they used silica sand and added a clay bond, and they were heat-treating the sand and clay before it passed on to the process.

Mr. Hudson, in his reply, said he must make an apology for calling Belfast sand a Scottish moulding sand. He did so because it was used extensively in the West of Scotland. Regarding tempering of sand, they had found in making their sand test that when they dried the sand by heat and added the water, the tests were always lower in the dry condition than when they allowed the sand to stand for about ten hours, and then made the test pieces. Why that was so he was not prepared to say. He agreed with Mr. Primrose's statement that in America they were utilising synthetic sands, employing a silica sand, and adding fireclay, but he did not think these sands were quite so good as the sands they used in this country.

Mr. Primrose said that a man who manufactured sand-plant had told him that the sand should be practically dry, and sieved before milling. He said it was necessary to dry it as it went through, and that they could add the bond required for each particular customer, using the same sand. These remarks, of course, apply to repetition machine-made moulds in a foundry having a continuous sand plant.

American Sand.

Mr. Winterton, referring to the remarks about American sand, suggested that the reason why Americans were utilising synthetic sands was that over there much of their sand was of such a silica nature that they had to add something to bring it up to the condition of the sands found in this country.

Mr. Hudson replied that he did not think they would ever get an ideal sand to serve the whole industry. They must just find out the best treatment for the sands they had.

Mr. Arnott recalled that Mr. Hudson's predecessor, Mr. Gardner, had lectured in that hall, and he was glad to see Mr. Hudson carrying on the good work. He thought Mr. Hudson was very courageous in tackling this big problem—one of the most important they were faced with. He would have liked to hear the name of Professor Boswell mentioned, because he thought it was to him that they owed all their recent knowledge of sands. Professor Boswell was a geologist, and it was a geologist's job to tell them what sands were available. They would find in Professor Boswell's book, which he advised them to read if they had not done so, a very good average of Scottish sands among others. One point must be remembered—that sands in this country were very cheap, a matter of a few shillings at the quarry. That was the prime difference between this country and America. In America they had very good sand quarries, but some were very far from the foundries.

Sieving Tests.

He noticed that Mr. Hudson was using the old-fashioned sieves in his tests. These sieves were very much out of date now, and he would suggest to Mr. Hudson that he use the punched copper sieve. The hole in a mesh made of gauze was not round, but square, and sand could be forced through. He could not see any advantage in using as many sieves as Mr. Hudson used, and thought that three or four were good enough to give a good mechanical grading. Regarding the settling test, as Mr. Hudson had pointed out, the clay could be seen in Fletcher's Test; but according to Fletcher only one-third the volume of clay shown was solid clay, hence, in the test tube one-third represented only ten per cent. by weight. Mr. Hudson had not said anything about the grain size of the sands tested for refractoriness. The two sands should be of the same grain size.

Permeability.

Then there was the question of permeability. The number of seconds for the air to pass through the specimen would increase in inverse proportion to the permeability—the more permeable the sand, the shorter the time. Mr. Hudson had said that unfortunately Blairgowrie sand had a high permeability. He presumed that milling increased the time taken in the permeability apparatus, but in that respect it must show reduced permeability. He would suggest that the two decimal places be cut out of the tables for the grading test. In such a test the actual percentage was quite enough. He would like to compliment Mr. Hudson on his excellent photographs. That was a thing they were apt to take for granted, but some of the photographs shown illustrated how much could be explained by really good photographs.

Mr. Hudson had referred to the McIlvaine instrument. He himself had once tried that instrument, and he found that it could not tell any more than a good moulder could tell. It was much used in America, where sand was mixed by unskilled men, who, presumably, did not know whether to make it like porridge or oatmeal. When the instrument showed high or low results, the same thing could have been told by a moulder of good experience. The instrument was not fine enough. When he tested all the heaps in the foundry he could not get any difference. Certainly when they added more water the instrument told them, but as he said, any good moulder could have told them that. One thing had interested him; what degree of uniformity was experienced in successive deliveries from one source? In one research Paper he had looked over the worker had taken samples from the top, middle and bottom of the seam, and when these were compared the differences were often very great. After all, one only needed to look in a sand-bin to find anything from gravel down to the finest of dust. They could not attribute exactly any properties to one particular sand. They might say that the sand had general properties, but they might get very material differences in one delivery. That was not to be wondered at in view of the low cost of these sands. The price they paid for them would not pay the quarries, he presumed, even to riddle the sand.

The Subsidence Tests.

Mr. Hudson, in reply to the statement about punched copper sieves, said that there was considerable controversy about these sieves. Judging from the work of the German investigator he had referred to, who passed the sand through silk sieves, he did not think that the results even with punched copper sieves would be any more accurate than with the ordinary wire sieve. Personally he did not like sieving as a test at all. He would much rather use Fletcher's subsidence test. For one thing it was quicker, as it could be done in five minutes, as against an hour in the case of sieving. He had quite an open mind as to the advantages of punched copper sieves over wire sieves. He did not think either kind was accurate. He wished to point out, moreover, that working to fine limits was out of the question in the Paper he had presented. Regarding the question raised about Fletcher's subsidence test, he quite agreed that all the deposit at the top of the tube was not clay, but it was impossible to tell how much was clay and how much was silt. Mr. Arnott had said that one-third of it was clay. With some sands it might be, but with others it might not be. With sand of such a fineness it was sufficient to be considered as clay or silt. Then it had been suggested that milling should be done before testing for refractoriness. He quite agreed, but what value would it have for practical application? The sand had to be used for moulds as it arrived in the foundry. Nowadays the tendency was to use green sand as much as possible. He quite agreed also with the correction Mr. Arnott had made in his statement in regard to permeability, but he thought that the practical man would quite understand his use of the term permeability.

Mr. Arnott had said that the McIlvaine meter was of less use when there were skilled men in the foundry. Again he quite agreed, but in his place they found that most of their defective castings came from the foundry where the work was done by unskilled men, and it was there that the McIlvaine meter was useful. In America the same conditions prevailed, and in America the instrument was in general use. He still maintained that in a foundry where the work was done by unskilled men the McIlvaine meter was useful. Regarding the degree of uniformity in different consignments of sand from the quarry, they had found quite a degree of variation with one sand and another, but this was not the case with all consignments. Some quarries took pains to deliver as uniform a sand as possible. Some quarries had quite good equipment.

Standardised Moulds.

Mr. Laurie said it was obvious that in the short time Mr. Hudson had been with them in Scotland he had put in some very good spadework, and he thought Mr. Hudson would prove an acquisition to the Scottish Branch. He understood that Mr. Hudson was trying to evolve standard sands for standard purposes. Standard sands could only be of the fullest advantage where standard moulds were the order. In general work conditions varied so much. The same degree of ramming would not be suitable for flat work and deep work alike, or the same strength of sand for light as for heavy work.

Influence of Organic Matter.

Dr. Hyman said that there was one aspect of moulding sands which Mr. Hudson had not dealt with, and that was the question of the presence of combustible organic matter in sand. He thought that the permeability of sands had been stretched too much, and that liberation of gas caused by the action of the molten metal on combustible organic matter was the cause of much of the trouble. If one took a sample of sand and dried it at 200 deg. C., and then heated it to the temperature at which it came into contact with molten metal—1,000 deg. C. or more—one often found a loss of about 1 per cent. The liberation of gas which caused this loss of 1 per cent. was probably the cause of many of the failures. He would like Mr. Hudson's opinion on that point.

Mr. Hudson agreed that the question of combustible organic matter in the sand was very important. In Fig. 20, which they had seen showing the refractory test on clay, Blairgowrie sand and Loudoun loam, the metal in contact with the clay was all blown on the surface. They had all heard those who said that permeability in a moulding sand was not necessary. The argument was that casting was done successfully in a chill mould, which had no permeability, and that therefore permeability was not necessary. If one cast metal on to a firebrick it lay quietly. There was no blowing. His opinion was that the blow holes were solely due to the organic matter in the clay being turned into gas. This was a very important point, and permeability was of no importance provided that there was no gas generated from the mould. They must have permeability, and the need for it was greater or less according to the amount of gas formed with steam or the decomposition of organic compounds.

Venting.

Mr. Longden said he knew from experience the need for venting with green sand. One had to add to the natural permeability of the sand by vents. When one was engaged in the production of the heavier classes of castings and had to face the problem of the elimination of scabs and what not, one had no room for doubt that this question of permeability was important. If the sand was

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* See "Scottish Moulding Sands," by F. Hudson, pages 262 *et seq.* and 276 *et seq.* of the current volume.

sufficiently open in texture there was less need for vents. In the absence of vents one was liable to get scabs and blowing in certain classes of work. The problem was simply that of providing an easy mode of exit for the products of the decomposition of part of the bonding materials of the sand. There were one or two points he wished to raise. Mr. Hudson had presented some very good illustrations. In one he showed a slab cast in a mould made with various kinds of sand, and the degree of ease with which these portions detached themselves from the casting indicated their suitability. That was a very good test, but it was necessary to get a little more information about that. In heavier castings, which might be cast in green sand, one would probably have to use a special sand, stronger and more open. It was not true to say that when they had found a sand which gave maximum quality on surface appearance by surface appearance they had found an ideal sand for every purpose in green sand. He had not the slightest doubt, for instance, that Blairgowrie sand would be quite unsuitable for many classes of work on account of its closeness. If only one class of work was being done one could, of course, get a standard sand suitable for that class of work, but in a jobbing foundry there was no one sand that would fill the bill for all kinds of green-sand work. For dry-sand work it was, of course, different. The qualities in respect of sands which had been dealt with in Mr. Hudson's Paper were all of first-class importance. Some time ago, as an alternative to a local silica sand, he had sent for Southport sand. It cost 2s. 6d. per ton on rail at the quarry, but by the time it had reached him it had cost 19s. a ton. That would show that it did pay to consider what their local resources were, and he thought that Mr. Hudson deserved their gratitude for the work he had done for them—work which he thought he might call pioneer work.

Helping the Jobbing Shop.

In his reply Mr. Hudson said that in the case of heavy castings the importance of knowing the properties of the sand was not so great as in the case of lighter work. One very rarely found a heavy casting defective. A good foreman would ensure that all heavy castings went out sound. It was in a jobbing shop where unskilled labour was employed that the value of these tests came in. He felt that Mr. Longden's remarks about the refractory test were quite correct, but, as he had pointed out, Blairgowrie sand was the most refractory sand they had found, yet it was no good for any class of moulding—except perhaps aluminium—because it was so dense. One must adjust the conditions to the job. By watching the ramming effect and controlling the moisture content they had a fair chance of turning out defective castings below 5 per cent. regularly. Their aim in his place was to make the sand standard and the moulding methods standard. In the previous week their defective castings were 4.7 per cent., with light castings not over 2 cwts. In their heavy foundry the defectives were about 0.1 per cent. Their total defectives that week on about 150 tons made amounted to about 3 per cent. He thought they would agree that that showed the value of knowing something about their sands.

At the conclusion of the discussion Mr. Longden announced that the next meeting was Problem Night, and that Mr. Hudson had agreed to attend so that his Paper, discussion on which had already been so full, might be further discussed.

New Honour for Sir Robert Hadfield.

Sir Robert Hadfield, Bart., F.R.S., has received an official intimation by cable that he has been elected a Foreign Associate of the National Academy of Sciences, Washington, D.C., an honour held by only ten other living Britishers. The National Academy of Sciences has 225 living members, all of them distinguished in some department of science, and is in many ways the equivalent in the United States of the Royal Society.

A Mighty Casting.

In a lofty shop in a street in Croydon, in Surrey, there has recently been made the greatest bell ever cast in England. This bell, destined to be sent to New York, is in height over 8 ft., and has a circumference at its mouth of more than 30 ft. Its weight is 18¼ tons, and its clapper—a curiously artistic bar of iron—weighs no less than 12 cwt. Its note is that known to musicians as a low C.

Art, science and craftsmanship are all indispensable in the making of a great bell. The draughtsman must be equal to setting out the complicated drawings upon which all founding is based; the pattern-maker must be a man of intelligence and of a very high order in his work as a carpenter, and the foundryman must know well the consistency of the sand to be used and in particular its condition; he, the man by whom the pattern is reproduced in the moulding box, must have the steadiest of hands and an eye for the most minute detail.

On the proportions of the copper and tin which go to make the alloy of which a bell is made the success of the result in the matter of tone very largely depends.

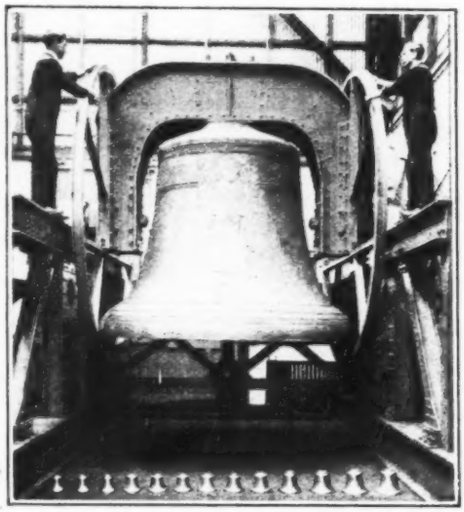


Fig. 1.

The "Bourdon" for the Laura Spelman Rockefeller Memorial Carillon, Riverside Church, New York. Nett weight—after tuning—18 tons, 5 cwts., 1 qtr., 18 lbs. The Largest Bell ever Cast in England. Gillett & Johnston, Croydon, England, February, 1928.

The sound of this great bell, which, by the courtesy of the founders, the writer was permitted to hear, is one of so great a volume that even in the ample shop in which it hangs no real appreciation of its undeniable beauty is there possible.

Great Paul of St. Paul's Cathedral, Great George of Bristol, Great Peter of York, Big Ben of Westminster and the great, yet unnamed bell of the Town Hall of Nottingham, with many other gigantic bells with enormous yet beautiful voices, can in no way rival the immense volume of sound sent out by this future dweller of the Riverside Church of New York.

Close by the monster casting stand in the foundry workshops row upon row of other large bells which in any other circumstance would easily call forth exclamations of astonishment and wonder. Here there are bells of 7, 12, 13 tons and of less weight, each with a clapper and each emitting, when struck, a truly wondrous and beautiful tone. In the limited space (which, however, was some 60 ft. high) the less vigorous the blow the sweeter the note appeared to be. But it is a campanological truth and one easily understood that in one sense a single note struck on a great bell is more impressive than many notes following each other in succession.

Not one of all these great bells on view had canons by which to be suspended; all apparently were to hang directly from the headstock. This is not a peculiarity of the foundry of Messrs. Gillett and Johnston. It appears, if we may judge from more than one recent example of the founding of large bells, that the canon is gradually losing its place as part of a big casting.

The illustration, kindly supplied by the founders, to whom, and to their representative, Mr. S. Cooksey, for much courtesy we are greatly indebted, show the great bell. Its size may be easily imagined by the contrast of the men standing by it. The frame upon which the bell hangs will go with it to New York.

Fig. 1 shows the giant bell in its frame: the curiously artistic and oblong form of the clapper is not perceptible in the photograph.

Comparative Tests on Malleable Cast Iron.

By S. S. Nekryty.

The tests were carried out by the author in the mechanical laboratory of the Politechnicum in Kief, Russia, under the supervision of Professor K. K. Siminski, on specimens received from the Luberetzky Agricultural Machinery Works, where the American method is used, and from the works "Malleable Cast Iron" of the Kief Metall-Trust, which employs the European method.

The analysis of the black heart samples, as cast, was T.C., 2.65; Si, 1.42; Mn, 0.26; S, 0.022; and P, 0.08 per cent.

The castings were annealed in a mixture of hammer scale and metal chips. The annealing furnaces have a combined wood-coal-oil firing arrangement. The duration of heating was 71 hours, whilst the whole cycle of firing (from the moment of charging until the discharge) was seven days. The excess of air in the furnace was 1.14 (average for the whole cycle).

The maximum temperature in the furnace reached 860 deg. C. The carbon was reduced in the course of annealing by 0.3 per cent., whilst the combined and amorphous carbon contents analysed out at 0.09 and 2.25 per cent. respectively. The sulphur content was increased by 30 per cent., and was, after annealing, 0.028 per cent. The Si, Mn and P are usually not affected by annealing.

The white heart samples, except those for determination of proportionality limits, were made to similar specification at the works of the Malleable Cast Iron Company, where the average yield of good castings was 51 per cent. of the weight of metal charged. The samples were annealed in an oxidising medium consisting of 20 per cent. of new ore (hematite iron containing approximately 90 per cent. Fe_2O_3), and 80 per cent. old, *i.e.*, which had already served for a previous annealing. The annealing furnace was coal fired.

The annealing of every kg. of castings required 1 kg. more fuel as compared with the process at Luberetzky Works. The duration of firing was 142.6 hours, whilst that of the whole cycle was eight to nine days. The maximum temperature reached in the furnace was 1,050 deg. C., and the excess of air in the furnace (average for the whole cycle) was 1.2. The analysis of samples after annealing was:—C (amorphous), 0.80; C (combined), 0.11; Si, 0.47; Mn, 0.17; S, 0.12; and P, 0.14 per cent.

Mechanical Tests.

The samples from both the works mentioned were tested under identical conditions, whilst to assure a high accuracy in calculation all test pieces were turned down 1.0 to 1.5 mm., except those for static tension, which were tested with the skin intact.

Conclusions.

The data of mechanical tests show the incontestable superiority of malleable iron produced at the Luberetzky Works, which satisfies all the standard requirements for malleable cast-iron products, even those of the American Standard Specifications.

It must also be considered that the European method of annealing requires 140 per cent. instead of 40 per cent. of 7,000 conventional heat units in terms of fuel, and that the total cost per ton of production of American malleable cast iron is less than that of the European.

The Iron and Steel Institute.

ANNUAL MEETING IN LONDON.

The Annual Meeting of the Iron and Steel Institute was opened on Thursday last at the Institution of Civil Engineers, Great George Street, Westminster. At the outset the retiring President (Mr. F. W. Harbord) occupied the chair.

Report of Council.

The Council of the Institute in their report for 1927 state that during the year 67 new members and 9 associates were elected, 10 associates were transferred to membership, and 12 members were reinstated. Fifty-three members and one associate resigned their membership during the year, and the names of 30 members were removed from the register owing to the non-payment of their subscriptions. The total membership of the Institute on the register on December 31, 1927, was accordingly as follows:—Patron, 1; honorary members, 5; life members, 81; ordinary members, 1,879; associates, 17; total, 1,983. The deaths of 30 members occurred during the year, and the Council record their sense of the great loss to the Institute incurred through the deaths of the following:—Mr. Edward Steer, who had served on the Council since 1910; Judge Elbert H. Gary (Chairman of the U.S. Steel Corporation and President of the American Iron and Steel Institute), who was elected an Hon. Vice-President of the Institute in 1922; and Mr. Charles F. Rand (New York), who was made an honorary member in 1921.

Finance.—The income for the year, apart from that of the Carnegie Scholarship Fund and of the Special Purposes Fund, was £7,831, and the expenditure was £8,710, as compared with £8,136 and £8,160 respectively in 1926. The adverse balance of £879 in the accounts for the year 1927 is chiefly due to the increased cost of the publications of the Institute.

Andrew Carnegie Research Scholarships.—On the recommendation of the Carnegie Research Committee, grants were made by the Council during the year to the following candidates:—

B. S. SMITH (Sheffield), £100, to assist in carrying out research work under the direction of Professor C. H. Desch at Sheffield University on behalf of the Heterogeneity Committee, the subject being the viscosity of molten steel.

DAVID BINNIE (Glasgow), £100, to assist in carrying out research work under the direction of Professor J. H. Andrew at the Royal Technical College, Glasgow, on behalf of the Heterogeneity Committee, the main subjects being the determination of the liquidus and solidus of carbon and alloy steels, and a study of reactions of sulphides in liquid and solid steels.

R. M. COLLES (London), £100, to carry out a research on the transfer of heat in heat exchanges used in the iron and steel industry.

EDWIN MORGAN (Birmingham), £100, to carry out a research on the electrical and dilatometric properties of cast irons at temperatures up to 1,000 deg. C.

T. F. PEARSON (Dudley, Worcs.), £100, to carry out a research on graphitisation in iron-carbon alloys.

E. VALENTA (Skoda Works, Limited, Czecho-Slovakia), £100, to study heat- and acid-resisting cast irons containing chromium-silicon-aluminium.

G. R. WOODVINE (Shrewsbury), £100, to study the influence of nickel upon the wearing properties of case-hardening steel.

Changes on the Council.—Mr. E. H. Saniter was elected Vice-President to fill the vacancy caused by Mr. Harbord's accession to the Presidency, and Mr. W. G. Gray has been elected a member of Council to take the seat vacated by Mr. Saniter. Lieut.-Col. Maurice L. Bell, Dr. W. H. Hatfield, and Mr. A. O. Peech have been elected members of the Council to fill three seats which became vacant at the end of 1926. In accordance with Bye-law 10, the names of the following Vice-Presidents and members of Council were announced at the autumn meeting as being due to retire at the annual meeting, 1928. *Vice-Presidents.*—Mr. George Hatton, C.B.E.; Mr. Alfred Hutchinson; and Mr. William R. Lysaght, C.B.E. *Members of Council.*—Mr. E. H. Saniter; Mr. John Craig, C.B.E.; the Hon. R. D. Kitson, D.S.O., M.C.; Mr. Cyril E. Lloyd, M.P.; and Professor Cecil H. Desch, F.R.S. Mr. Saniter having since been elected a Vice-President, Mr. W. Simons, being next due to retire, now retires in his place. No other members having been nominated up to one month previous to the annual meeting, the retiring members, in accordance with the announcement made at the autumn meeting, but subject to the change specified, are presented for re-election.

MR. BENJAMIN TALBOT.

President of the Iron and Steel Institute.

MR. BENJAMIN TALBOT, the inventor of the continuous process of steel manufacture which bears his name, was born in Shropshire in 1864. His earliest experience in steel manufacture was obtained at the Ebbw Vale Works, after which he went to assist his father, who owned the Castle Ironworks at Wellington, Shropshire, where, besides gas puddling furnaces, he was operating a "Clapp-Griffiths" steel plant with small basic open-hearth furnaces. In 1890 Mr. Talbot became superintendent of the Southern Iron & Steel Company of Chattanooga, in Tennessee, U.S.A., in order to start the basic open-hearth process in the Southern States. Whilst there he experimented for the Tennessee Iron & Coal Company, of Birmingham, Ala., with their silicious pig-iron, as up to that time basic pig-iron had not been made in the South. He conceived the idea of working a preliminary continuous basic-lined refining furnace for desiliconising, and this is now in large use in England under the name of the basic-lined gas-heated mixer. In 1893 he accepted the position of steelworks superintendent at the Pencoyd Steel Works, in Pennsylvania, where he commenced the manufacture of basic open-hearth steel, and in 1899 brought out the continuous method of steel-making. In 1900 Mr. Talbot read his first Paper before the Iron and Steel Institute on the "Continuous Steel Process," being followed by one in 1903 on the same subject. In 1900 he resigned his position of manager of Pencoyd, when the Pencoyd Works were absorbed by the United States Steel Corporation, and returned permanently to England to develop the continuous steel process, which was taken up by some of the largest steel companies, including the Cargo Fleet Iron Company, Limited, South Durham Steel & Iron Company, Limited, Frodingham Iron & Steel Company, Limited, and others, in this country. In 1905 he read a Paper before the Institute upon "Segregation in Steel Ingots." For many years Mr. Talbot has been engaged in improving the design of large steel furnaces with the object of increasing production and reducing costs. He is also the inventor of a successful mechanical gas producer, and of a process known as "The Talbot Hydro-carbon Lining," by which iron and steel pipes are lined by centrifugal force with a special hydro-carbon lining. Mr. Talbot was awarded the Elliot Cresson Gold Medal and the John Scott Medal of the Franklin Institute of Philadelphia in 1908 in recognition of his metallurgical inventions, and also, during the same year, was awarded the Bessemer Medal of the Iron and Steel Institute in recognition of his research in the manufacture of iron and steel. During the war he acted in an expert advisory capacity to the Ministry of Munitions, and also as a member of the Departmental Committee appointed by the Board of Trade to consider the position of the iron and steel trades after the war. He is a member of the Advisory Committee for Coal and the Coal Industry under the Mines Department, and of the Permanent Committee on Basic Slag under the Ministry of Agriculture and Fisheries. Amongst his many other connections Mr. Talbot is deputy-chairman and managing-director of the Cargo Fleet Iron Company, Limited, and the South Durham Steel & Iron Company, Limited, and is interested in several other important iron and steel and colliery companies on the North-East Coast. During the present year he is also President of the National Federation of Iron and Steel Manufacturers.

Statement of Accounts.

DR. H. C. H. CARPENTER (Hon. Treasurer), in presenting the balance-sheet and statement of accounts for 1927, called attention to the tendency evident in the past three years for the expenditure to rise while the income remained stationary, or even fell slightly. The income and expenditure account for the year 1927 showed a deficit amounting to £879, which revealed a serious position for the Institute. It was attributable to various causes, but mainly to the increased expenditure on the publication of the "Journal" containing the Papers, discussions and abstracts.

The Annual Report and Statement of Accounts were adopted unanimously.

Induction of Newly-Elected President.

The chair was then vacated by Mr. Harbord, and taken, amid hearty cheering, by the new President, Mr. Benjamin Talbot.

SIR ROBERT HADFIELD, Bart. (Past-President), proposed a hearty vote of thanks to the retiring President, Mr. Harbord, who had given unlimited time and very able help in the conduct of the affairs of the Institute.

The vote was carried by acclamation.

MR. F. W. HARBORD thanked Sir Robert for the kind words he had used in proposing the resolution, and the members for the hearty manner in which they had accepted them.

The PRESIDENT (Mr. Benjamin Talbot) said that in electing him to the high office of President he considered that the highest honour but one which he had ever received had been conferred upon him, as he ranked the receipt of the Bessemer Medal in front even of the Presidency of the Institute.

Presentation of Bessemer Gold Medal.

The PRESIDENT said his first duty, a very pleasant one, was to present the Bessemer Gold Medal to Mr. Charles M. Schwab, President of the American Iron and Steel Institute and the Chairman of the Bethlehem Steel Corporation. Some of them knew Mr. Schwab very well. He (the President) had been fortunate enough to know him for a great many years; it was in 1892 that he first had the privilege of meeting him. The Council of the Iron and Steel Institute, in considering the award of the Bessemer Medal, must be influenced by distinguished contributions to the progress of the industry, whether by research, the application of scientific principles or operative ability. It was perhaps unusual, and it was, indeed, one of the rare combinations for which the industry was invariably seeking, to find in one personality the three qualities of scientific knowledge, technical ability and administrative capacity, but in Mr. Schwab they had an outstanding example of such a combination linked with force of character, as the result of which he had, by his own ability and energy, forged his way to the leading position in the great iron and steel industry of the United States. Having reviewed Mr. Schwab's career, the President concluded by expressing, on behalf of the Members, their very great pleasure in seeing him there that day. He had peculiar pleasure in presenting the Bessemer Gold Medal.

MR. CHARLES M. SCHWAB, who was received with prolonged applause, said that when Mr. Talbot spoke of the days gone by it seemed almost impossible for him (the speaker) to realise that he was practically the Dean of the steel industry of America. He was rounding out his 50th year of service in the manufacture of iron and steel. The dream of his youth that this honour should come to him as a fitting culmination of a long career had been consummated that day. He had received a good many honours in his life in different directions, but they all paled into insignificance in his

own estimation compared with the Bessemer Medal, which had always stood as the hall mark of what had been greatest in their business. Having referred in generous and eulogistic terms to his business experiences with British financiers and others, and recalled many personal memories, Mr. Schwab remarked that though he had grown rich and wealthy in manufacturing and all that sort of thing, it did not count anything to him. At his time of life the one thing that meant much to him was the approval of those with whom he had been for so many years associated, and to have this token of approval from them meant more than anything he could possibly find words to express. He was in Europe two months ago, when he was notified by Mr. Harbord, and by their Secretary, Mr. Lloyd, that the Medal was to be conferred upon him. He had just been home for two weeks, and although duties were pressing and he was not young, and although he had crossed the Atlantic 80 times in 43 years, nothing could stand in the way of his making a trip across the Atlantic again for the sole purpose of personally expressing his appreciation of the great honour which they had done him. He was going back at the end of the week to America, but he would take with him a heart overflowing with appreciation for their kindly remembrance of the old American steel-master. As a citizen of America he pledged them during his lifetime his undivided help in anything that would promote friendship between their two great countries.

The President said he was sure Mr. Schwab would be pleased to know that Mr. Farrell, the President of the United States Steel Corporation, had sent him the following cable:—

"Accept the gratitude of our industry in the United States for the high honour conferred upon my colleague, Charles M. Schwab."

The President then delivered his Presidential Address.

Presidential Address.

By B. Talbot.

(Abridged.)

If the addresses of Past-Presidents, many of them scientific and technical men eminent in their day, were put together they would form very interesting reading, as they record the advances of the iron and steel industries during the past years very clearly, and they cover the ground thoroughly. I have found it somewhat difficult to select a subject for my address, but finally came to the conclusion that possibly an account of my forty years' personal experience in the development of the basic open-hearth process might be of general interest.

Just before the advent of the basic process, or a little over 50 years ago, A. L. Holley, the most noted American metallurgist and steelworks engineer of his day, wrote in one of his reports in summing up his conclusions about the open-hearth process as follows:-

While the Bessemer process has reached a high degree of perfection, so high, indeed, that the directions of great improvement are not obvious, the open-hearth is availing itself of new accessories in every direction. The Bessemer looks back to a splendid development. The open-hearth looks forward to a splendid development.

In this country [U.S.A.] to-day, the Bessemer is by far the cheaper method of producing the ordinary and some of the finer grades of structural steel. The product is not only cheap, but when made of the best materials, and with the skill and care that many of our experts can bestow, it is trustworthy and excellent.

The open-hearth process, on the contrary, is performed mostly in small furnaces and in works too limited to fully economise labour and maintenance. It receives no aid from any preliminary preparing or refining operation. Excepting in a few details, and in the arrangement of a few works, the plant is little better than it was five or six years ago. The practice, however, in most of our works is excellent, and the product of some of them is not exceeded in quality anywhere in the world. For very soft, very hard, and very pure products, and for steel castings, the present open-hearth has great advantages over the Bessemer. The materials, however, are of the most expensive character.

But what are the indications of the future? The Bessemer must be chiefly confined to irons very regular in silicon, and hence the most costly to make—to irons pretty low in phosphorus and so requiring ores that average the dearest—to crude irons that are not purified from phosphorus, because they would then also be purified from silicon, and would not be hot enough to blow. If remelting the pig is saved by working directly from the blast furnace, then the ores and the blast-furnace practice must still be more regular and costly.

The open-hearth has these advantages, some of them secured and some within reach: (1) It is not dependent for temperature on the ingredients of the materials, hence as far as heat is concerned it can digest anything that bears the name of iron. (2) It can, as well as the Bessemer, take its material direct from the blast furnace or from the cupola. (3) The greater part or the whole of its materials can be purified by a preliminary process, and hence the cheapest ores can be used whatever their quality. This can be done in whichever of three ways is best suited to the particular case: (*a*) The direct process, as by the Siemens rotator; (*b*) fluid refining, as by Bell's and Krupp's methods, and (*c*) mechanical puddling. (4) Very impure scrap, such as old iron rails, may be purified in connection with pig, by fluid refining.

The conclusion is inevitable that the open-hearth process is about entering upon a development which will largely increase the use of steel, not only as a substitute for wrought iron and cast iron, but with new adaptations and in new directions.

The late S. T. Wellman once recalled a prophecy by Holley that the open-hearth process would some day go to the funeral of the Bessemer, and, judging from the foregoing quotation from Holley's report in 1877, he certainly anticipated a much greater future development in the open-hearth than in the Bessemer.

The world's output of steel in 1878 was some 2,780,000 tons, which was divided amongst the various steel-producing countries as follows:—Great Britain, 980,000 tons; United States, 730,000; Germany, 460,000; France, 280,000; Belgium, 120,000; Russia, 100,000; Austria, 90,000; Sweden, 2,000; total, 2,762,000 tons. The British output for the year 1878 was made up as follows:—Acid Bessemer, 806,208 tons; acid open-hearth, 175,438 tons.

Mr. Edward Williams stated in his presidential address in 1879 that the world's production of open-hearth steel in 1878 was 350,000 tons, which was all acid. According to information kindly supplied by Mr. M. S. Birkett, of the National Federation of Iron and Steel Manufacturers, the total world production of steel ingots and castings in 1927 is estimated at 99,090,000 tons, of which 12,100,000 tons were acid, and 83,880,000 tons were basic, the remainder being steel made in the electric furnace or in small converters. Of the 83,880,000 tons of basic steel, 64,180,000 tons were made in the basic open-hearth.

When we see the enormous increase in consumption of steel in 50 years, and especially how the output of the open-hearth process has grown in this period, it shows that Holley was correct in his forecast of the increase in the uses of open-hearth steel. As to the statement credited to him by S. T. Wellman that the open-hearth steel process would attend the funeral of the Bessemer, the time has not yet arrived to make even tentative arrangements for its obsequies. In fact, it looks as if both processes will work together for an indefinite period, as there is room for both so long as the cost of producing basic Bessemer steel is less than that of basic open-hearth, and there may be some purposes for which Bessemer steel is preferred.

Holley's report was written before S. G. Thomas announced to the world his epoch-making invention, in his Paper read in the spring of 1879, in which he proved that he had successfully dephosphorised pig-iron in a basic-lined converter, and had produced a satisfactory quality of steel. This great invention stopped all further development of mechanical puddling, as well as the work on preliminary dephosphorising, which had been solved by Sir Lowthian Bell in this country and by Krupp in Germany in their washing processes. If the basic process had not been invented at that time, no doubt there would have been interesting developments in these preliminary slag-washing refining processes, as it had been discovered that it was possible to dephosphorise at a comparatively low temperature and yet retain carbon in the liquid bath.

It was fortunate that Bessemer was an exceptionally able mechanical engineer as well as a great inventor, as his process was so revolutionary. There has been very little fundamental change in the design of the tilting converter since he finished with it, except in regard to size, although A. L. Holley made certain improvements of detail, such as the movable bottom, which enabled the tuyeres to be changed more rapidly, and also in the general layout of the converting department.

When S. G. Thomas invented the basic process he had the benefit of the engineering experience and skill of Bessemer, Holley and others. His task was to perfect his basic lining, make it more durable, and find out the exact composition of the liquid metal which gave best results in the converter, just as Bessemer had to do in his early experiments.

As soon as it was seen that the basic process was a success in the converter, it was taken up

Mr. C. M. Schwab,
Bessemer Gold Medallist.

Mr. Charles Michael Schwab was born in Williamsburg, Blair County, Pa., on February 18, 1862. While he was still a boy the family removed to Loretto, in Cambria County, Pa., where he was educated in a local school and at St. Francis College. From Loretto he went to Braddock, Pa., and found work in a grocery store. Among the customers of the store was Captain William R. Jones, then Superintendent of the Edgar Thomson Steel Works of the Carnegie Company. Impressed by the young grocery clerk's energy and intelligence, he offered him a job at the works driving stakes at a dollar a day. Captain Jones soon discovered indications of the mechanical genius and capacity for the management of men, which were the great factors in Mr. Schwab's later success, and the young man was early given new and greater responsibilities. Indeed, it was not long after he began his dollar-a-day job as a stake-driver that he was superintendent of the Edgar Thomson Works, then the foremost steel-making plant in existence. In seven years he was at the head of the Engineering Department of the Carnegie Company. The great Homestead Steel Works were erected under his supervision and in accordance with his plans. On the death of Captain Jones, Mr. Schwab was appointed superintendent of the Edgar Thomson Steel Works, and in 1892, when the Homestead Works were re-opened after the historic strike, he was made superintendent of that plant also. Mr. Schwab proved to have a genius for organisation and administrative tact, and his work then and afterwards was so thorough in the management of men that in 1896 he was made a member of the board of managers of the Carnegie Company, and the following year was elected its president. He had thus at the age of thirty-five become the chief executive officer of what was then the greatest manufacturing corporation in America, and had attained that place in fifteen years from a beginning as a dollar-a-day stake-driver. During the negotiations leading up to the establishment of the U.S. Steel Corporation it was Mr. Schwab who was the intermediary between the late Mr. Andrew Carnegie and the other parties to the bargain, and whose cogent arguments persuaded the other negotiators to pay the price at which the Carnegie interests were offered. When the consolidation was effected, Mr. Schwab, at the age of thirty-nine, became president of the world's greatest corporation. When after three years he resigned the presidency, he left this magnificent working organisation in perfect order, and still retains large personal interests in the Corporation and its subsidiary companies. After leaving the presidency of the U.S. Steel Corporation, Mr. Schwab obtained a controlling interest in the Bethlehem Steel Corporation, of which he is now chairman of the board of directors. During the war he became the advisor of the Administration in regard to engines of war and munitions, and was called in April, 1918, to the post of Director-General of the Emergency Fleet Corporation. His great achievements in this connection are matters of history. Mr. Schwab was elected President of the American Iron and Steel Institute on October 28, 1927. The Institute has a membership of 1,485 active members and 594 associate members.

by those who were interested in the Siemens open-hearth process, and here again a furnace was at hand ready to be adapted. While Siemens had conceived and worked out successfully the beautiful principle of regeneration in his furnace, and while Bessemer was developing his process, comparatively little improvement in design of the open-hearth had been made since the first furnace was built.

The Siemens furnace in use at that time, as designed for the acid process, gave sufficiently good results, but it was soon found that with a basic hearth it was very expensive to maintain and repair. The hearth was supported more or less by the regenerators, as they were exactly underneath, but the gas and air ports and uptakes were too near together, and air spaces for cooling were inadequate.

In 1884 we find in the "Journal of the Iron and Steel Institute" a Paper by Mr. Dick on the Batho furnace, the design of which was the result of the joint effort of Messrs. Wailes, Hackney, Riley, and Dick. It was a practical change in design from the original Siemens, and it contained good and bad points. The good points were in the removal of the regenerators to the end, and in the independent support of the hearth on columns or piers, so that free access was possible underneath the hearth. The bad points were the circular hearth, movable roof, and air ports through the roof at right-angles to the gas port. In addition to improving the design of the furnace, the question of suitable pig-iron was involved. Some of the pioneers made their work more expensive and difficult by using Staffordshire cinder pig, which was the cheapest iron then produced, but very unsuitable for the purpose on account of the great variation in the percentage of silicon and sulphur, and the exceedingly high phosphorus. This was mainly the reason why such small outputs were obtained, and why the working campaign of a furnace was so short, while the repairs were excessive, owing to the necessity of keeping heats in the furnace for long periods in order to obtain steel sufficiently low in phosphorus and sulphur. Although Thomas and Gilchrist had previously mentioned in their Paper that the basic process should work in the open-hearth, the first published account of the basic open-hearth process that I have come across is contained in Mr. Gillitt's Paper, read in 1883-84 before the Institution of Civil Engineers, describing the working of a small 2- to 3-ton furnace at the Farnley Ironworks in 1882. Here they used a reasonable mixture of phosphoric pig-iron and scrap, and claimed to have obtained satisfactory results.

In Staffordshire, about 1884, Mr. Wailes began to produce basic open-hearth steel at the Patent Shaft Works, but he used a most impure pig-iron, which made the operation difficult and expensive. Lincolnshire pig-iron at that time, although more expensive than cinder pig-iron, would have yielded more economical results.

Mr. J. H. Darby about that time erected basic open-hearth furnaces at Brymbo, and, having blast furnaces under his control, was able to make a basic pig-iron low in silicon and sulphur suitable for the process, and credit is due to him for some of the most important pioneer work done. His method for making high-carbon steel by the addition of solid carbon was a most important step in the development of basic open-hearth practice, and it is now in use in almost every basic open-hearth plant which produces rail and medium-carbon steels.

Mr. Harbord, our retiring President, read in 1886 his valuable Paper on the basic open-hearth process, which came at the right time, as it lucidly explained the theory and practice of the process, although it will be noticed here that the pig-iron used would to-day be considered very unsuitable.

I became interested in the process and commenced work with it in 1887. At the outset I found that Staffordshire common cinder pig was a very difficult metal to employ, as hours were taken to bring the phosphorus and sulphur down to satisfactory limits. To overcome this I used two furnaces, the first to melt the pig-iron, desiliconise, and remove some of the phosphorus; the second to finish off the heat. The furnaces were small, being of only 2 to 3 tons capacity, and the following gives the history of a typical test:—

From 2 to 3 tons of cinder pig were charged with oxide and lime and melted in the first furnace, the analysis of the iron being as follows:—

	C.	Si.	P.	S.	Mn.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
As charged cold into first furnace ..	3.0	1.46	3.96	0.24	1.40
As poured into second furnace ..	2.00	Trace	2.60	0.09	0.15
Steel as tapped ..	0.09	Trace	0.07	0.054	0.46

The steel was tapped two hours after pouring the refined metal into the second furnace. By working in this way it was found that heats were made in less time, the heavy expenditure on repairs was greatly reduced, and the steel produced was of better quality.

Good work was being done in one or two other works in England where the basic open-hearth process had been introduced. About 1889-90 Mr. Mannaberg started the process on a considerable scale at the new steelworks put down by the Frodingham Iron Company and erected under his supervision. The pig-iron made from Lincolnshire ores was very suitable for the process, and steel of excellent quality was produced, which did much to convince engineers that basic open-hearth steel was a reliable and satisfactory material for general engineering purposes. These works were the first in England to erect a tilting furnace to operate the continuous process.

In 1890 I went to America to introduce the manufacture of basic open-hearth steel in the Southern States. In going through various works there I found a great development in open-hearth basic practice going on. The Homestead works were putting in a large installation for those days.

In the development of the acid open-hearth in the United States it was fortunate that they had a man of such ability and practical experience as the late S. T. Wellman as a pioneer. What Holley had been to the acid Bessemer, Wellman was to the open-hearth. In 1887 he built at the Otis Steelworks, Cleveland, Ohio, a furnace in which he departed from the Siemens design then in use, and made a great advance by arranging cinder chambers under the uptakes of the ports, and by moving the regenerators forward, so that the slag could not drop amongst, and rapidly clog up, the spaces between the chequer bricks, and also by carrying the weight of the furnace body on girders supported on brick columns independently of the regenerator arches. Shortly afterwards basic open-hearth furnaces were built in the United States on these lines. In fact, one may say that this furnace became a new standard design, and very little alteration was made in the design of fixed basic open-hearth furnaces from about 1895 until comparatively recently, except in the arrangement of the ports, and, of course, in size, with the necessary increase in strength.

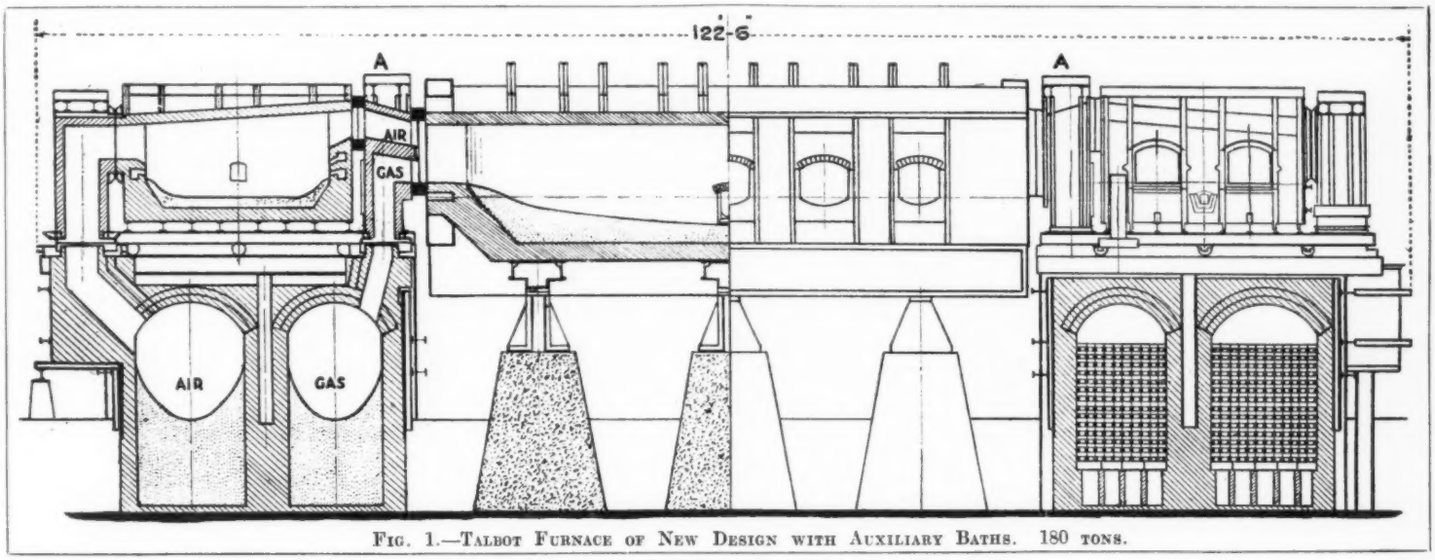


Fig. 1.—Talbot Furnace of New Design with Auxiliary Baths. 180 tons.

While these basic open-hearth furnaces were being introduced S. T. Wellman brought out a further great improvement, namely, the charging machine—perhaps his greatest invention. This machine made it possible for furnaces of much larger capacity to be easily and rapidly charged, and did away with a large amount of manual labour. It was also a great boon to the furnacemen during the high temperature of the summer months. At that time the small electric motor was coming into use at steelworks for all secondary power, superseding small steam engines and hydraulic power. In fact, those who witnessed these changes in the decade of 1890-1900 would say that the electric drive for charging machines, overhead cranes, roller tables, machines, and tools in steelworks was largely responsible for increasing output and decreasing costs.

H. H. Campbell was the first to use tilting open-hearth furnaces, having put them into operation at Steelton, Pa., in 1889. These furnaces tilted centrally, but as the block was fixed a space had to be left open between the tilting and fixed portions. It was in 1895 that S. T. Wellman built his rolling furnace for the Illinois Company, Chicago.

In my experiments in 1891-92 on de-siliconising the siliceous pig-iron in Alabama in fixed furnaces, I had become interested in the tilting furnace, and had recommended the introduction of a large basic-lined tilting furnace to run continuously for the purpose of de-siliconising the siliceous blast-furnace metal by means of a basic slag

instead of using an acid Bessemer converter for the purpose. When I decided to build a tilting furnace for the continuous process I looked into the merits of these designs, and finally selected Wellman's method of rolling forward instead of tilting centrally, as being the better for the purpose. We did not care for the cylindrical shape of the body of the furnace as built at the Illinois Steelworks, and decided to design the furnace ourselves with flared or sloping sides. As it was decided to have close joints between the tilting sections, movable ports with water-cooled chills and capable of being moved backwards and forwards were used. The flared sides were introduced for the double purpose of more easily repairing the back wall and slag line, and for holding the side walls (especially on the charging side) more firmly when tilting. Also, during slag line and wall repairs, the angle of the wall could be varied by tilting the furnace as desired.

The continuous process being very well known, it is unnecessary to say much about it except that when first introduced some authorities prophesied dire results as to heats going through the bottom, but since the process has been in operation I have never heard of any heats having broken through the hearth proper. The other interesting development in the continuous process was the bringing about, when desired, of the carbonic oxide reaction, in which the carbon in the bath is rapidly oxidised simultaneously with the phosphorus.

Since 1899 numbers of tilting furnaces gradually increasing in size up to 250 tons capacity, and of different designs, with and without sloping sides, both centrally tilting and rolling forward, have been built in many steel-making countries, and opinions vary as to which design is the better, the tilting or the rolling furnace, as they both give satisfactory results. Personally, I must say I favour the tilting furnace of, say, 200 to 250 tons, as against the fixed furnace of large size. The hearth in a tilting furnace of large capacity can be much more easily controlled, and the facilities for repairs are much greater than with a fixed one, and for ease of removal of slag there is no comparison. Again, another advantage which the tilting furnace has over fixed furnaces of very large size is that it enables the use of smaller ladles; the pouring of the steel is therefore effected through smaller nozzles than is possible where ladles of 150 tons have to be used, and it must be admitted that this factor has an important effect on the satisfactory rolling of the steel.

Of course, there are not many fixed furnaces of even 150 tons capacity, but in large works the tendency is to increase the size. There seems to be now no adequate reason why tilting furnaces of over 300 tons capacity should not be used, especially in large works, and I hope to see them gradually installed.

It is somewhat significant that Holley, in his report of 50 years ago, outlined preliminary refining operations for the acid open-hearth process, and through the period of the development of the basic open-hearth process preliminary refining has been more or less used.

A modification of the basic open-hearth process, known as the Bertrand-Thiel process, was introduced in Germany about 1896. This consisted essentially in the use of two Siemens furnaces working in combination: one was known as the primary furnace, into which the pig-iron, oxides, and lime were charged and melted; the other as the secondary furnace, which received the refined liquid metal from the primary furnace. In a later development of the process fluid metal from the blast furnace was introduced into the primary furnace. By keeping the heat in the primary furnace comparatively low, the phosphorus is very largely removed in this furnace, whilst the carbon remains at about 2 per cent., and this constitutes one of the chief advantages of this modification of the process.

The Hoesch process was another method for effecting the same object; the first slag was separated by tapping the metal into a ladle, and the metal was then returned to the same furnace without the slag.

Monell, in America, charged adequate quantities of oxide of iron and limestone, preheated them, and then poured in liquid blast-furnace metal, refined it, and flowed off the slag.

The so-called "duplexing" method is used largely at times in the United States, in which an acid Bessemer converter is employed to desiliconise and more or less de-carbonise metal containing too much phosphorus for acid working. By this means very large outputs have been obtained when working in conjunction with furnaces of 200 tons capacity, an output approaching 5,000 tons per week having been produced from a single furnace. We hear also of outputs of 2,000 tons per week per furnace both in Germany and in the United States from large fixed and tilting furnaces, using scrap and liquid metal as a charge. When we think of the weekly outputs of the pioneers in the basic open-hearth, which 45 years ago would be under 100 tons per week per furnace, the present outputs indicate the world's progress.

Fig. 1 shows a sectional elevation of my new design of open-hearth furnace with auxiliary hearths. The auxiliary hearths are mounted on a frame with wheels, so as to give a longitudinal movement for the double purpose of opening the joint of the furnace when tilting, and also for the rapid removal and exchange when desired of the movable water-cooled throat section A, which contains both the gas and the air ports.

The objects aimed at in the design are to enlarge the hearth area in one unit, to increase output, to decrease repairs, and to reduce costs.

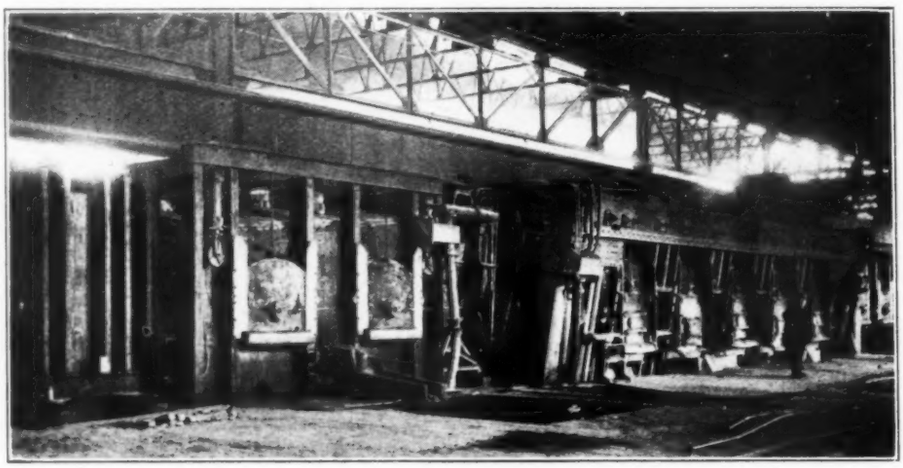


Fig. 2.—New Talbot Furnace: General View.

A radical departure has been made from the standard furnace in use to-day by the introduction of auxiliary hearths, which are used to melt the solid pig-iron of the charge when cold pig is used. In furnaces which use a large percentage of scrap, say 60 per cent., the 40 per cent. of pig-iron is melted in the auxiliary hearths, and when required it is tapped and poured into the heated scrap charge in the main hearth. In those works where liquid blast-furnace metal is available it is poured into the auxiliary hearths, partially refined, the temperature increased, and the metal is then tapped and poured into the main hearth to be worked down into finished steel.

It will be seen in Fig. 1 that, in order to augment the heat available from the main hearth in the auxiliary hearths, gas jets are used when melting or refining liquid pig-iron. When in use these gas jets are preferably reversed with the furnace, so that all the gas streams run in the same direction.

Perhaps the idea of mixing and burning a small quantity of gas in the incoming heated air from the regenerator, which further increases its temperature before it burns the gas in the main hearth, is the most novel idea to be observed in the new design. The amount of carbonic acid in the incoming heated air (due to the combustion of the gas in the auxiliary chamber) is inconsiderable, averaging only about 3 per cent. when producer gas is used, and we have experienced no difficulty in obtaining combustion of the gas and all the necessary heat required for rapidly working the charge in the main hearth. On the outgoing end gas is used when required in the auxiliary hearth, with or without air as may be necessary.

The results obtained during the past few months are considered satisfactory, as without increasing the area of the centre or main hearth the output has already been increased by at least 50 per cent. in those furnaces which are working the same mixture of cold pig-iron and scrap as they were before. The furnace which is being supplied with liquid blast-furnace metal has increased its output by more than 33 per cent., and a greater increase is expected as soon as a large area in the auxiliary hearths is available. Of course, these auxiliary hearths can be added to large fixed furnaces when there is sufficient space between them.

It is hoped that further experience with this new design of furnace will show that it is a distinct advance upon present types. No doubt, opportunities will be given in the future thoroughly to discuss its merits or criticise its shortcomings.

This address commenced with an extract from a report by Holley half a century ago, which contained a forecast of the possibilities of future steel production. Seeing that the production of steel has risen from 2¾ million tons in 1878 to 99 million tons in 1927, I am not bold enough to make a forecast of what the world's consumption may be 50 years hence. It does appear, however, with our present knowledge, as if the basic open-hearth process will produce by far the greatest portion of the world's requirements, as the ores from many of the known deposits in the world yield a pig-iron more suitable for this process than for any other.

The process also absorbs vast quantities of miscellaneous scrap without it being necessary to select it by analysis. As the uses of steel increase more scrap will be available, and this must be remelted and returned into circulation.

The fact that 64 million tons of steel ingots were produced last year by the basic open-hearth process conclusively proves that the steel is in every way suitable for general engineering purposes, otherwise it would not be accepted by engineers all over the world. The future manufacture of steel can be left with confidence to our successors, as they will have a greater knowledge and larger opportunities than we have had, but they will have new problems to solve. The problem which faced the great inventors of steel—namely, Bessemer, Siemens, and Thomas—was to produce satisfactory qualities in different kinds of plain carbon steel. Sir Robert Hadfield opened up a new era with alloy steels when he demonstrated to the world the valuable properties of his manganese steels.

Other workers have been and are working upon steels containing various alloying elements to produce steels to meet new engineering requirements, and it looks as if in the future there will be greater possibilities of using such steels for many other purposes with every prospect of success. Possibly the greatest problem of all is to prevent, as far as possible, the ravages of corrosion in steel structures, and if this cannot be entirely prevented we must all work to mitigate it as much as is commercially practicable.

XUM

Blast-Furnace Practice in Natal.*

By J. E. Holgate, B.Sc., and R. R. F. Walton, Newcastle, Natal.

(*Continued from page* 321.)

Calcination Troubles.

In the first place, the carbonate was calcined in open piles at the mines, using about 5 per cent. of small coal. It was soon discovered that the 5 per cent. of free carbon in the ore was more than ample to promote calcination without extraneous fuel. Several thousand tons were calcined in large heaps and put through the blast furnace in admixture with the oxide ore. Although it was possible to reach an average of 56 per cent. in the calcine, the process was objectionable for the following reasons:—

(1) Lack of uniformity of product. The greatest heat was generated in the centre of the heaps and caused excessive clinkering; the material was then difficult to size and consequently proved refractory in the furnace. The outside layers were never completely burnt and thus a variable analysis existed throughout the heap, with consequent greater difficulties in burdening the furnace.

(2) Deterioration in mechanical condition of the ore was accentuated by further repeated handlings. The hard, dense carbonate ore on being heated was split up into laminations which became more friable and the ultimate proportion of fines became appreciably increased. Under more precise control in closed kilns this difficulty might be overcome by allowing the lumps of ore to attain a stage in calcination where vitrification just commenced. But the problem is a difficult one, as actual clinkering must be avoided, and in open heaps, where the ore is in the slightest degree under-burnt, friability results.

(3) Expensive handling of the raw ore. A large amount of native labour was required for building the heaps, while refilling tubs and transporting calcine back to loading bunkers at the mine was no light task, though, of course, mechanical methods could be introduced eventually to save labour costs.

It was naturally concluded that certain advantages could be reaped by installing a system of closed kilns, but in the meantime small proportions of raw carbonate had been smelted in the furnace. The results were so encouraging that before installing kilns it was decided to experiment, as far as possible, with the carbonate, and obtain data, keeping in view the fact that a credit must be shown that would at least balance the extra railage cost of raw ore.

Before the end of 1926 development of the mine was proceeding well, but there were many engineering and mining difficulties to get over before the maximum tonnage could be guaranteed for daily requirements, while the stock of outcrop ore was almost exhausted. For an output of, say, 4,200 tons of pig-iron per month it was necessary to ensure a continuous supply of 10,500 tons of carbonate per month. In order to tide over the development period, and also the period of experiment on carbonate ore, it was decided to take a quantity of oxide ore (50 per cent. iron) from Rodell's Farm; this ore was taken purely as a temporary expedient, and for some months has constituted about 40 per cent. of the average mixture, working quite satisfactorily.

The proportion of carbonate in the mixture was steadily increased from December, 1926, when 33⅓ per cent. was functioning well, up to 50 per cent., and by June 66⅔ per cent. carbonate was yielding excellent results. The furnace drove quite smoothly on the whole, although the presence of some slightly bituminous coal from the upper seam at times caused periods of high pressure through a little wedging action in the furnace. The loss in flue-dust was decreased, and the gas was still highly combustible at the stoves and boilers in spite of an increased content of CO_2.

For a short period before closing down the furnace it was possible to make a run on all raw carbonate, and the results were very gratifying, particularly in respect to coke consumption. With all oxide ore the average coke consumption had been in the neighbourhood of 2,100 lb. per ton of pig. This was steadily reduced until for a short period on basic iron with all raw carbonate the low figure of 1,734 lb. was obtained.

The authors are quite convinced that as a general practice raw carbonate can now be smelted with a consumption not exceeding 1,800 lb. over a prolonged period, making allowances for maximum driving and any minor disturbing factors that arise. They have not yet reached final conclusions on all aspects of the subject, as it is desirable to make certain observations over a larger period; but the main principle has been established that the fuel saving, combined with the better mechanical condition of the ore as carbonate, and uniformity of operation, amply compensate for the adverse railage factor.

It has been evident that sufficient surplus heat was generated in the upper regions of the furnace to promote calcination without any loss of heat at the hearth, while the 5 per cent. of free carbon is a fuel addition which, on the basis of 2½ tons of ore per ton of pig, is equivalent to—

$$\frac{5}{100} \times 5{,}000 \times \frac{100}{86} \text{ lb.} = 292 \text{ lb. of coke per ton of pig.}$$

Principles of Carbonate Ore Smelting.

Unlike calcination in the open air, the oxide resulting from the action of heat in the furnace shaft is a ferrous oxide—not Fe_2O_3. The process of iron smelting, speaking broadly, consists in the abstraction of oxygen from the oxides of iron and the melting of reduced iron sponge. It should follow, therefore, other things being equal, that the lower the state of oxidation of the ore, the less work the furnace has to perform, as the heat requirements for melting iron and slag in the hearth are constant. The lower oxides of iron of mineral formation, such as magnetite, occur in exceedingly dense masses, so that it is their mechanical condition which interferes with reduction, rendering them refractory. Although the extra oxygen from the higher oxide of iron involves an increased exothermic reaction with the carbon monoxide in the shaft, this means a greater quantity of CO which has to be generated previously at the tuyeres from coke—an expensive fuel.

If the work to be done in the shaft is reduced by having an ore in a lower state of oxidation, that work will be performed more efficiently. Less work, then, is thrown on the hearth, and a smaller coke requirement is sufficient for this. Again, less coke in the hearth means less air to be blown, while, incidentally, there is less moisture to be decomposed, and the air can also be heated to a higher temperature owing to its reduced velocity through the stoves.

Further economy in coke consumption is then arrived at by the further saving through the somewhat smaller weight of slag which has to be melted in conjunction with the reduced proportion of coke ash. Also, the fact cannot be ignored that the minimum weight of coke to be burnt per ton of pig promotes faster driving of the furnace, with a cutting down of radiation, conduction, and cooling water losses per ton of pig. One might express the final coke saving mathematically as the sum to infinity of a series of terms in geometrical progression, each saving in coke automatically involving a further saving because of reduced slag, higher blast heat, etc., these economies decreasing by a fixed ratio.

Summing up this theoretical consideration, it appears quite uneconomical to oxidise the lower oxide of the carbonate ore in a calcining heap or a kiln simply to reduce it again in the furnace.

Table I.—*Coke Consumptions recorded during Campaign.*

Period.	Raw Carbonate in Mixture. Per cent.	Coke per ton of Pig. Lb.
Half-year ending Dec. 31, 1926..	25	2,218
Half-year ending June 30, 1927..	52	2,091
3 months ending Sept. 30, 1927..	59	1,995
August, 1927	58	1,941
Sept. 15 to 30, 1927	100	1,734

The coke consumptions recorded during the campaign are given in Table I. Although the results are naturally affected to a certain extent by many other variable factors, one can observe the progressive decrease in coke consumption as the percentage of carbonate ore increases.

It is also interesting to record the average analyses of blast-furnace gas taken over a series of determinations during normal working conditions at the furnace (Table II). We commenced with all oxide ore from the Prestwick outcrop, and followed the investigation through, until, for a short period, the authors were able to observe the effects of working on 100 per cent. carbonate. The estimations were taken with a Standard Orsat apparatus.

Table II.—*Variation in Gas Analysis with Increase of Raw Carbonate.*

Raw Carbonate in Burden. Per cent.	Average Gas Analyses.			Ratio CO/CO_2.
	CO_2.	CO.	Total Carbon Oxides.	
Nil (all oxide)	10.9	27.9	38.8	2.56
33⅓ ..	12.5	27.4	39.9	2.19
50 ..	13.5	27.3	40.8	2.02
66⅔ ..	14.45	27.5	41.95	1.90
100 ..	15.0	27.8	42.8	1.85

It will be observed that in each phase the percentage of CO in the gas is practically constant. The CO_2, however, rises steadily, and the percentages of the latter when plotted graphically against the percentage of carbonate in the ore mixture show almost a straight line up to 66 per cent. It is intended, however, to follow up the investigation by taking a longer series of gas analyses of the higher proportion of carbonate, as there is much scope for ascertaining valuable information on the relation between the CO/CO_2 ratio and particular furnace conditions in our special practice. Up to a certain point it would appear that the extra CO_2 in the gas corresponds roughly by weight to the CO_2 in the carbonate ore.

There is also a steady average drop in the gas temperature as the percentage of carbonate rises in the mixture, other things being equal, until for the higher proportion temperatures as low as 180 deg. Fah. have actually been observed. As previously suggested, this is confirmation of a natural conclusion that, less oxygen being carried in with the ore to oxidise CO to CO_2 in the shaft (an exothermic reaction), less heat is evolved in the shaft, with consequent lower temperatures of the top gases.

Table III.—*Analyses of Pig-Iron and Slag.*

Grade of iron.	Pig.				Slag.				Ratio $\frac{CaO + MgO}{SiO_2}$.
	Si. Per cent.	S. Per cent.	P. Per cent.	Mn. Per cent.	SiO_2. Per cent.	CaO. Per cent.	MgO. Per cent.	Al_2O_3. Per cent.	
Basic ..	1.00	0.05	0.30	1.50	31.0	28.0	18.5	19.0	1.5
No. 1 foundry	2.75	0.02	0.30	1.25	32.0	33.5	11.5	20.0	1.4

Analyses of Pig and Slag.

Using a mixture of roughly equal parts of Dundee and Vryheid cokes, the slag analyses given

* A Paper read before the Spring Meeting of the Iron and Steel Institute.

in Table III represent the best conditions of working for the corresponding grades of iron. For high-silicon irons it is usually advisable to use ½ Taungs limestone in order to keep the manganese down to 1.25 per cent. About 80 per cent. of our output, however, is of basic quality for the steelworks.

Furnace Records for August, 1927.

These are given for one typical month, using a mixture of carbonate and oxide ores.

Output: 4,152 tons { Basic pig .. .. 74 per cent.
Foundry pig .. .. 26 per cent.

Average Analyses of Products.

Pig.	Per cent.	Slag.	Per cent.
Silicon	1.42	SiO_2..	31.23
Sulphur	0.051	CaO..	28.47
Phosphorus	0.31	MgO	18.36
Manganese..	1.42	Al_2O_3	19.45
		S	1.75
		MnO	0.73
		FeO..	0.55

Raw Materials per Ton of Pig.

Carbonate ore	2,697 lbs. = 58 per cent.
Oxide ore	1,931 lbs. = 42 per cent.
Total ores	4,628

Analysis of Ore Mixture (as received).

Fe.	SiO_2.	CaO.	MgO.	Al_2O_3.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
43.7	8.0	0.30	0.20	3.8

Analysis of Coke Mixture.

Coke .. .. .. 1,941 lbs.

Carbon.	Ash.	Sulphur.	H_2O.
Per cent.	Per cent.	Per cent.	Per cent.
86.03	12.13	0.89	0.95

Analysis of Dolomite.

Dolomite.. .. .. 1,617 lbs.

SiO_2.	$Al_2O_3 + Fe_2O_3$.	CaO.	MgO.
Per cent.	Per cent.	Per cent.	Per cent.
2.2	3.5	28.6	18.7

Slag per ton of pig, 1,500 lbs.

Average blast pressure	9 lbs. at engines.
,, blast temperature	1,160 degs. F.
,, gas temperature	310 degs. F.
,, engine revolutions	51 per min.
,, air blown per min.	19,900 cubic feet.
,, moisture content of air	3 grains per cubic foot.
Weight of ore per round (6 barrows)	11,344 lbs.
,, coke per round (6 barrows)	4,758 lbs.
,, dolomite per round (3 barrows)	3,963 lbs.

Working Costs of Production.

The working costs of production recorded below relate to the month of August, 1927.

Output: 4,152 *Tons.*

Raw materials.	Consumption per ton of pig.	Weight of material used.	Price per ton, delivr'd	Total cost.	Cost per ton of pig.
	Lbs.	Tons.	s. d.	£ s. d.	£ s. d.
Iron ores: Prestwick carbonate..	—	5,599			
Rodell oxide ..	—	4,009			
		9,608	10 5	5,004 6 10	
Manganese ore..	—	59	31 2	92 5 8	
Total ores..	4,657	9,667	—	5,096 12 6	1 4 6
Coke	1,941	4,030	28 3	5,692 13 7	1 7 5
Dolomite ..	1,617	3,356	13 0	2,181 16 0	0 10 6
Total raw materials ..				12,971 2 1	3 2 5
Coal: Boilers, 153 tons ..			9 6	120 13 0	0 0 7
Loco., 80 ,, ..					
Sundries, 21 ,, ..					
Salaries: No. of staff, 15				547 10 0	
Wages—Operating: 25 Europeans..				669 11 4	
do. 175 Natives ..				444 5 6	
Maintenance: 22 Europeans..				382 1 2	
do. 29 Natives ..				86 8 11	
Total salaries and wages				2,129 16 11	0 10 3
Compound expenses (accommodation and feeding all native labour) ..				199 5 0	0 1 0
Stores: Operating..				215 18 7	
Maintenance				320 15 7	
				536 14 2	0 2 6
Laboratory				92 17 7	0 0 5
Sundry and general charges				307 0 0	0 1 6
Total working cost (excluding depreciation and interest charges) ..				16,357 8 9	3 18 8

Tuyeres and Cooler.

During the campaign of 15½ months only one tuyere was lost, and no coolers; the furnace ran for 14 months without losing a single tuyere. The steep bosh, combined with a good water circulation, was no doubt largely responsible for this regularity. The feed pipes (1¼ in. dia.) for both tuyeres and coolers entered at the bottom with the outlet at the top, and this system prevented any possibility of the accumulation of sediment.

Stoves and Boilers.

These maintained their efficiency for the whole period without cleaning, thanks to the efficient dust catchers. The fine dust which accumulated in the checkers was removed about every three days by firing a " gun " underneath the checkers. The boilers were taken off in turn for cleaning throughout about once every three months. The dust problem is, however, not a serious one, and with carbonate ore becomes negligible. There is thus no need, in our opinion, for any special system of gas cleaning.

GENERAL AND ECONOMIC CONSIDERATIONS GOVERNING THE PIG-IRON INDUSTRY IN SOUTH AFRICA.

This subject opens up an important field for discussion, and is perhaps a little beyond the scope of a practical paper on blast-furnace practice. One of the authors, however, has been considerably involved in the technical controversy that is still taking place between the Union Steel Corporation and the Union Government. The latter are proposing to pass a Bill whereby a State-controlled iron and steel industry shall come into being, with its centre at Pretoria in the Transvaal, their fundamental reasons being as follows:

(1) Large deposits of iron ore exist round Pretoria.

(2) It is a convenient distributing centre for the largest industrial centre of the country, which is the Rand.

(3) State control of a vital key industry would bring about the immediate acquisition of the necessary capital to expand the industry to meet the further requirements of South Africa for finished steel products, it being assumed that private enterprise is not sufficiently progressive.

(4) It would afford partial relief of the unemployment question as regards white labour. This factor appears to be a particularly important one with the Labour party, who at present control the balance of power in the Government.

Reverting to the technical aspect of pig-iron manufacture, the whole case for private enterprise must lie primarily with the experts' consideration of the available reserves and quality of iron ores. The authors are not qualified to express a final opinion as to the most economical centre for a large blast-furnace plant. From actual experience, however, it has been proved that any decision in favour of Pretoria should be reserved pending a further investigation by experts of the resources of Natal, and particularly the Prestwick ore deposits.

The Pretoria ore reserves are undoubtedly very large, but the ore is of a quartzite character containing 47 per cent. of iron and 21 per cent. of silica. In the Government scheme, it is proposed to mix this with about 40 per cent. of a rich hematite ore from the Crocodile River, about 130 miles north of Pretoria. This latter ore also exists in very large quantities, but it is 60 miles from rail-head, which would involve new railway construction. The coke consumption required for smelting this mixture of ores is undoubtedly much larger than is the case with Prestwick ore, as confirmed by the Government technical report.

Again, it has been clearly demonstrated that the Transvaal is deficient in supplies of coking coal. It would thus be necessary to carry a large proportion of the latter from Natal (Dundee or Vryheid) to Pretoria, a distance of about 300 miles, for the manufacture of coke at the site. This involves very heavy railway charges.

The Prestwick ore deposits in Natal are now developed on such a scale that it is possible to state with every confidence that future reserves of a uniform grade of ore will not be less than 10 million tons. In all probability the tonnage will greatly exceed this.

Newcastle was chosen as the site of the first blast-furnace, largely on account of the abundance of water in the neighbouring river, and the possibility of developing the local coal seams for coking, while the enterprising municipality offered special inducements to encourage the industry.

In view of the heavy carriage on the raw carbonate ore and the determination of its smelting properties with low fuel consumption, the natural outcome at the moment seems to be the establishment of the permanent blast-furnace plant at the Prestwick ore mine. The chief coking coal areas are in close proximity, while at Newcastle further investigation is required to determine the amount of coking coal available. There is also a river within a few miles of the ore mine, which will provide the water supply.

The future of the industry in South Africa is assured, as abundant natural resources exist, and with the growth of the population and development of other industries there is great scope in the variety of products that can eventually be manufactured. At present the Corporation's steelworks at Vereeniging are producing sections of all kinds, light rails, bars, wire and reinforcing rods, while the steel-casting department caters for the numerous requirements of the gold mines, railways, etc. At an early date a steel tube works will be in operation, to be followed by sheet and rail mills. As regards foundry iron, Newcastle now supplies practically the whole of the foundries in South Africa, and the quality has emerged from the severest tests against imported iron with a first-class reputation. The cost of production will be lowered very considerably later, as coke will eventually be manufactured very cheaply from Natal coals, the present contract price being artificially high. With increased ore tonnages, the cost of mining operations will also be reduced.

As regards the selection of the final site for the industry, other things being equal it will be largely a question of the cost of assembling the raw materials required per ton of pig, plus the cost of distribution of products to the main consuming centres.

In conclusion, the authors wish to tender their thanks to the Chairman and Directors of the Union Steel Corporation for their co-operation in allowing them to make use of the various official records and data. The Chairman, Major Butler, through his encouraging direction, has invariably made their duties most interesting.

The Influence of Nickel on Iron-Carbon-Silicon Alloys Containing Phosphorus.*

By Arthur B. Everest, Ph.D., and Professor D. Hanson, D.Sc. (Birmingham).

(*Continued from page* 318.)

THE INFLUENCE OF NICKEL AND PHOSPHORUS ON A REFINED IRON.

Since the experiments described, for which American washed iron was used, have given results different from those that might reasonably be anticipated in normal commercial practice, some further experiments have been made using a commercial refined iron as base.

In the following tests all castings have been made from one pig of the refined iron, which showed on analysis: Total carbon, 3.05; silicon, 1.87; manganese, 0.75; sulphur, 0.09; and phosphorus, 0.24 per cent.

Twelve castings were made in all, by adding 0, 1, 2, and 3 per cent. of nickel to the original iron, and again to the same iron with the phosphorus made up to 0.5 and 1.2 per cent. The method of melting, of making the phosphorus and nickel additions, and of casting was the same as before.

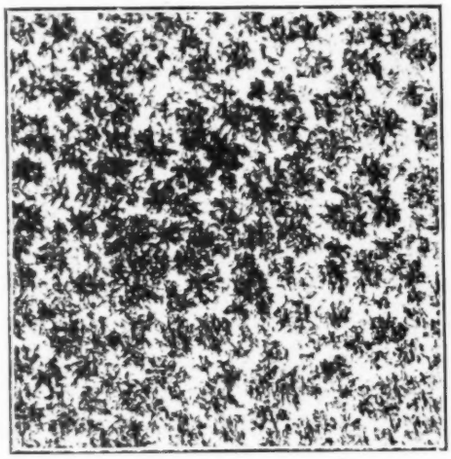


FIG. 11.—NETWORK STRUCTURE. SILICON 2.5 PER CENT., PHOSPHORUS 0.5 PER CENT. × 10.

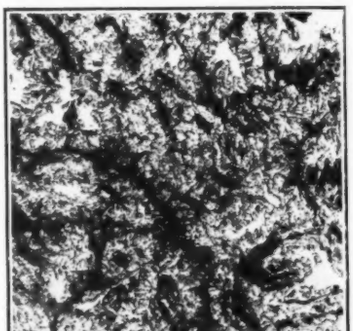


FIG. 12.—SILICON 1.2 PER CENT., PHOSPHORUS 0.2 PER CENT. × 100.

Experimental Results.

Analyses of Castings.—One complete analysis was made on each series—that is, representing each pot of metal. The carbons have also been determined on both the 0 per cent. and 2 per cent. nickel castings. The results of these analyses are given in Table II. In every case drillings were taken from the 1-in. section of the castings. These analyses show that the phosphorus contents of the irons are very close to those intended. Nickel contents are somewhat low, especially in the case of P92.

The ratio of graphite to total carbon shows that neither phosphorus nor nickel has, in this series of experiments, had any profound influence on the amount of carbon graphitised. In each case the addition of nickel has increased the rato, indicating a slight graphitising action. The first additions of phosphorus have lowered the ratio, while further additions have raised it slightly.

Fracture and Chill.

The ¼-in. step of each casting was broken across and the fracture examined. Casting P70 showed a fracture fine grey in the centre of the step and mottled towards the edges. Castings P80 and P90 showed, in the corresponding positions, white fractures with a trace of mottling in the centre of the step. In each case 1 per cent. of nickel rendered the fracture grey throughout.

The depth of chill from the tip of the ⅛-in. section was measured, and the results are shown in Fig. 7. Again phosphorus is seen to increase the tendency of the iron to chill, while the influence of nickel in eliminating this chill is even more pronounced in this than in the previous experiment. This confirms the observations on the fractures given above. All castings were readily cut with a hack-saw on the 1-in. section.

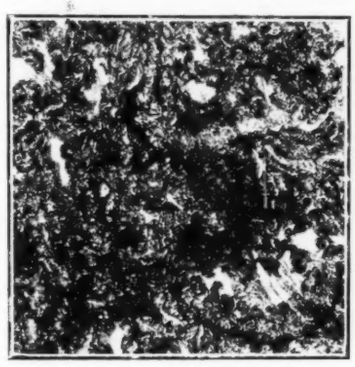


FIG. 13.—SILICON 1.2 PER CENT., PHOSPHORUS 0.5 PER CENT. ×100.

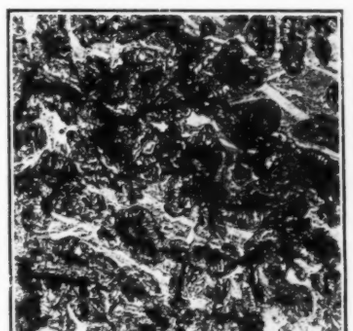


FIG. 14.—SILICON 1.2 PER CENT., PHOSPHORUS 1.2 PER CENT. × 100.

Hardness Determination.

These were made, as before, on each section of each casting, the mean of two results (or more if there were any discrepancy between the first two results obtained) being taken. In this case a load of 750 kg. was used in conjunction with a ball 5 mm. in diameter. It has been found that this combination gives the best results for cast irons over a range of section varying between 1 in. and ⅛ in.

TABLE II.—*Analysis of the Base Metal of each Series.*

	P70.	P72.	P80.	P82.	P90.	P92.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
TC	3.05	3.00	2.98	2.88	2.90	2.80
CC	0.78	0.70	0.81	0.76	0.74	0.70
Gr	2.27	2.30	2.17	2.12	2.16	2.10
Ratio of Gr to TC ..	74.4	76.7	72.8	73.6	74.6	75.0
Si	—	1.87	—	1.77	—	1.71
Mn	—	0.74	—	0.70	—	0.67
S	—	0.085	—	0.091	—	0.08
P	—	0.240	—	0.51	—	1.16
N	—	1.93	—	1.84	—	1.76

The results of these determinations are given in Fig. 8. A comparison with Figs. 4 and 5 shows that phosphorus has exerted a greater hardening action on the thinner sections of the castings of refined iron than it did on the synthetic iron used previously. A very considerable chilling effect due to 0.5 per cent. of phosphorus is shown on the ¼-in. step of the test castings, and to a slight extent also on the ½-in. steps as found in the castings made from washed iron. It is clearly demonstrated that 1 per cent. of nickel has in all cases eliminated this hardness produced by chilling. On the other hand, in the heavier sections, phosphorus has not shown so great a hardening action in this iron. In all cases the hardening action of nickel on the chill-free sections is confirmed.

On the whole, the ¼-in. and ½-in. sections, as shown in Fig. 8, have a hardness greater even than was the case of the low-silicon synthetic iron (Fig. 4); this is probably due to the lower total carbons occurring in the refined iron.

FIG. 15.—SILICON 1.2 PER CENT., PHOSPHORUS 0.2 PER CENT., NICKEL 3 PER CENT. × 500.

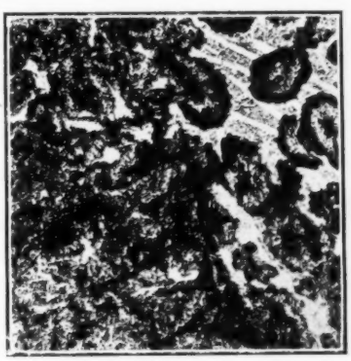


FIG. 16.—SILICON 1.2 PER CENT., PHOSPHORUS 0.5 PER CENT. × 500.

* A Paper read before the Spring Meeting of the Iron and Steel Institute.

Drill Hardness Tests.

Tests were carried out exactly as before; the results are shown by the curves in Fig. 9. There is, on the whole, more regularity in these curves than in those of Fig. 6. The increased drill hardness produced by increasing phosphorus is clearly demonstrated. The addition of nickel up to 2 per cent. again produces an increase in drill hardness, probably because of its refining action on the matrix of the iron. Three per cent. of nickel, however, in the lower phosphorus series is seen to produce a softer iron in this test than was the case with 1 and 2 per cent. of nickel. This feature is not indicated in the Brinell hardness curves of these irons; but, as will be shown later, the graphite obtained in the 3 per cent. nickel alloys is appreciably coarser than that obtained

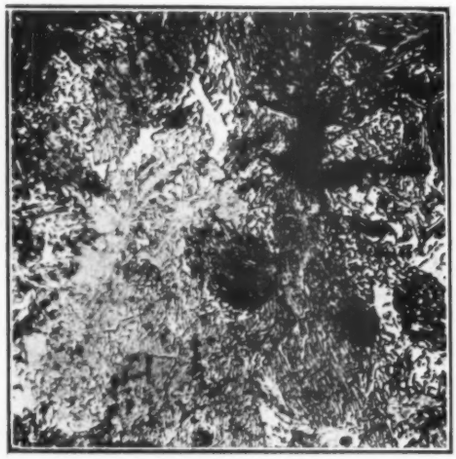


Fig. 17.—Silicon 2.5 per cent., Phosphorus 0.2 per cent., Nickel 3 per cent. × 500.

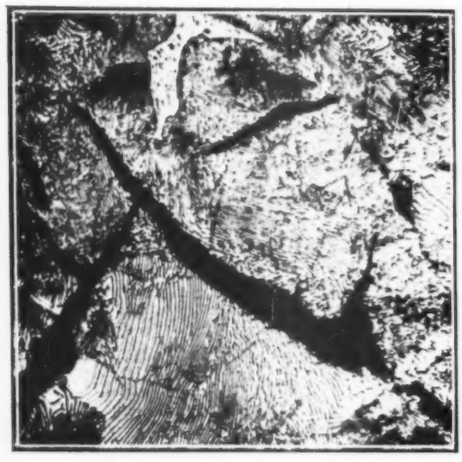


Fig. 18.—Refined Iron. Phosphorus 0.25 per cent, Nickel nil. × 500.

with lower percentages of nickel, and this probably has some connection with the changes in drill hardness mentioned above.

With 1.2 per cent. of P the irons become hard, entering into the ranges of irons not commercially machinable. The influence of nickel in this case does not appear to be so regular, but a general further hardening of the specimens is indicated with increasing amounts.

It is of great interest to note that the Brinell hardness curves for these specimens (1-in. section), as shown in Fig. 8, lie very close together, indicating that there is no direct relation between the drill and Brinell hardness values for this type of material. Phosphorus has a relatively small influence on the Brinell hardness, whereas, perhaps on account of the blunting action of the phosphide eutectic, it has a very pronounced influence on the drill hardness.

MICROSTRUCTURE.

Influence of Phosphorus and Nickel on the Graphite.

The composite micrograph, Fig. 10, illustrates the combined action of phosphorus and nickel on the graphite in the refined iron. As indicated, the horizontal rows represent series with fixed phosphorus and increasing nickel contents.

It will at once be apparent that both nickel and phosphorus separately render the graphite form in the original iron appreciably finer, but consideration of the whole set of micrographs shows that the effect of nickel is less in the higher phosphorus series. The finest graphite is shown with 2 per cent. of nickel and 0.25 per cent. of phosphorus, and it is only in this low-phosphorus series that nickel has a very marked influence on the graphite

Fig. 19.—Refined Iron. Phosphorus 0.25 per cent., Nickel 3 per cent. × 500.

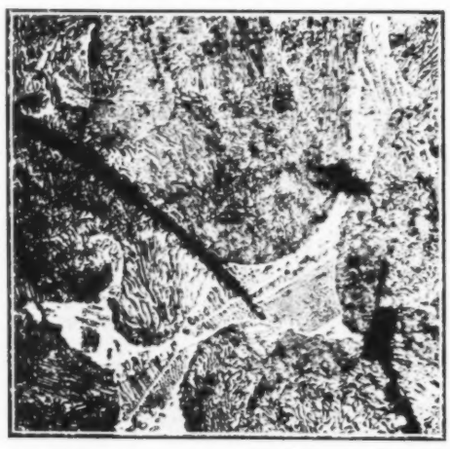


Fig. 20.—Refined Iron. Phosphorus 1.2 per cent., Nickel nil. × 500.

form. Even in this series, 3 per cent. of nickel appears to have produced a coarser form, confirming observations made on many irons that the maximum refining action of nickel is obtained at about 2 per cent.

Whereas nickel in its action on the iron renders the graphite form very fine, it will be noticed that phosphorus tends to render the graphite form globular. The action of nickel on this form of graphite is only slight. Increasing nickel renders the graphite form finer at 2 per cent. of nickel in the two higher phosphorus series, while in the last series 3 per cent. of nickel appears again to exert a coarsening action.

Etched Specimens.

In the etched specimens the form and distribution of the phosphide eutectic is much the same as in the corresponding phosphorus series in the previous experiments (Figs. 12, 13, and 14). Examination under higher magnifications shows that in each series the pearlite form is generally continuously refined by the addition of nickel. An example of this is seen in Figs. 18 and 19 showing specimens containing 0.25 per cent. of phosphorus and 0 per cent. and 3 per cent. respectively of nickel; in the latter case the pearlite is seen to be very finely lamellar.

Increasing phosphorus, however, also influences the form of pearlite, and a finer lamellar form is found in the higher phosphorus series without the addition of nickel (see Fig. 20). The addition of nickel to this iron, however, again causes further refining of the pearlite, which tends in the highest phosphorus series to become locally granular with high nickel.

These observations confirm those made previously on the synthetic alloys due consideration being given to the silicon content of this iron. It is interesting to note that whereas the graphite is coarser with 3 per cent. than with 2 per cent. of nickel the pearlite is continuously refined as nickel is increased up to 3 per cent.

Summary of Section II.

The influence of nickel up to 3 per cent. on a refined iron containing 1.87 per cent. of silicon, with phosphorus varying between 0.25 and 1.2 per cent. has been investigated in order to confirm the conclusions drawn from the similar experiments on synthetic irons, using American washed iron as base. The conclusions drawn from Section II confirm those drawn from Section I.

Phosphorus is found to render the iron very susceptible to chill, again producing white fractures in the ½-in. sections. With all phosphorus contents, however, 1 per cent. of nickel is effective in counteracting this influence. Increasing phosphorus rapidly impairs the machinability of this iron, as measured by the drill hardness. Small additions of nickel further increase this drill hardness by hardening the matrix of the iron.

Phosphorus also has a general hardening action on all sections, as measured by the Brinell test. Its action is not very marked, however, on the heavier sections of the castings. Nickel again shows a regular hardening action on all sections, except where chilling the casting has produced white iron, when nickel is effective in softening this iron. Nickel and phosphorus both show a refining action on the graphite in the iron, but with higher phosphorus the effect of nickel is small, and inappreciable when 1.2 per cent. of phosphorus is present. Both nickel and phosphorus are shown to induce a finer form in the pearlite.

Conclusions.

Summing up the results in both sections of this work, it is seen that:—Phosphorus increases the hardness of the iron, increases its tendency to chill, and renders it difficultly machinable. In the absence of chill, nickel produces its normal hardening action. Under conditions likely to produce chilled iron, nickel counteracts the chilling effect of phosphorus. The microstructures show that phosphorus tends to reduce the influence of nickel on the iron. More nickel is required to produce a given result in the presence of high phosphorus, where there is any tendency to chill, than would be required in the presence of lower phosphorus.

The authors wish to thank the members of the Nickel Committee of the British Cast Iron Research Association, which has co-operated with them in this work, and in particular Mr. J. G. Pearce, B.Sc., for arranging for some of the chemical analyses to be done in the laboratories of the Association, and Mr. J. E. Fletcher for assistance in designing the step-bar casting. They are also greatly indebted to Mr. F. O. Everard, of Messrs. Belliss and Morcom, Limited, who granted them facilities for carrying out the drill tests for machinability.

The annual general meeting and luncheon of the British Non-Ferrous Metals Research Association, whose headquarters are at Athenæum Chambers, 71, Temple Row, Birmingham, will take place next Monday in Birmingham.

Foundry Purchasing.—XXVI.

By Eric N. Simons.

The following up of orders to secure the desired deliveries is an exceptionally important part of the buying department's work. It must be remembered in this connection that delivery is often as much a factor as price in the placing of orders, and the supplier who does not keep his promises in this matter is to some extent obtaining work under false pretences. He is compelling the buyer to forfeit the economic advantages he expected to gain from quick delivery when he placed the order. It is, therefore, essential that the buyer, if he does not wish to lose this advantage, should do everything in his power to keep the supplier to his word. Obviously, if a buyer has ordered a casting to replace a broken one in a machine, and has agreed to pay a few shillings more per cwt. in order to get delivery in a week, he is worse off than he was before if he does not get delivery in the specified time. He has not only paid more money for his goods, but has gained no advantage in so doing.

A "reminder"—or, as the Americans whimsically term it, a "tickler"—should be sent out as soon as the promised delivery date for an order threatens to fall due. There are a good many different systems of ensuring that these reminders are sent out, and that outlined in a previous article is as good as any. It is not so much the perfection of the system that matters as the vigour with which it is followed. The best reminder system in the world will fail of effect if the clerk in charge of it neglects his work. A point to be stressed is the need for a definite delivery promise from the supplier. Without this, any reminder must be arbitrary, since it will probably have no relation to the actual length of time required to manufacture or deliver the goods on order. With a definite promise in his possession, the buyer has something to work on, and can begin to harass the supplier at the right moment. It is important, also, that the dispatch of reminder cards or letters should not be delayed until a day or so before the goods are due to arrive. Without some intimation from the purchaser that the delivery promise is taken to be serious, the best of firms will occasionally put an order on one side so that it can turn out first an order that it knows to be urgently needed. To prevent his orders being treated in this way, the buyer should give the supplier an adequately early intimation that he expects his goods to be delivered on the promised date. Of course, no hard-and-fast rule can be laid down as to the exact time before the promised date that the first card or letter should be sent. What would be right for one class of goods would be wrong for another. On this point the buyer or his assistants must use their judgment, based upon experience of how long it takes to deliver the materials in question, and upon the promise given by the supplier. For example, if the latter has indicated three weeks as his delivery period, the first card should not be delayed until the eighteenth day. At the end of a fortnight a card should be sent reminding the supplier that the goods are due in a week's time, and asking for an assurance that they will be ready. As the delivery date draws nearer, it may be necessary to send a second reminder. If the goods have not been delivered when the date of the promise is reached, then a sharp letter asking why should be despatched, and the matter should not be allowed to drop until the goods have been received, with an explanation of the delay. The buyer should always insist on a reasonable explanation of the delay, to avoid giving the supplier the impression that any old excuse will fob him off. The scheme outlined in a previous article has this one drawback, that it does not begin to worry the supplier until the actual date of the delivery promise is reached.

Recording Deliveries on Orders.

One now comes to the question of recording deliveries against orders. Here again every buyer has his pet scheme, alterations or modifications of which are anathema to him. The method adopted for single delivery orders will obviously not suffice for contracts against which many deliveries will be made over a comparatively long period of time. Some firms provide spaces on their order copies for the enumeration of deliveries, but the method of card- or loose-leaf delivery records, as previously described in an earlier article, is much the better.

The Importance of Advice Notes.

It is important that suppliers of any goods sent by rail or steamer should forward advice notes, preferably in duplicate, on the date of actual dispatch. The advantage of this is that it acquaints the buyer with the fact that the materials are on the way, saves him the trouble and expense of sending needless reminders, and enables him to put the matter in the hands of the traffic department, so that any possibility of delays en route may be eliminated. This is specially important when a firm is working on a very close margin of raw material stocks. The duplicate advice is better than the single advice, because it enables the buying department to send one copy to the storekeeper, or whoever has the work of receiving the goods on arrival, while retaining the other for reference, or for the use of the traffic manager. Another reason why advice notes are important is that some goods are perishable, and therefore cannot be stored in any other than small quantities, frequent and quick deliveries having to make up for bulk consignments. Delay on the railway through ignorance of despatch might mean the complete loss of a valuable lot.

Handling Correspondence Relating to Orders.

A point not previously discussed calls for mention here: the handling of the correspondence connected with orders. Obviously, certain orders call for a great deal of correspondence, leading to the accumulation of a large number of papers, sketches, prints, photographs, and so forth. For example, an order for a rotary kiln or a cement plant might involve correspondence lasting over a year or two. To file all these documents in the ordinary correspondence files would mean an endless amount of labour in turning up letters. It is better, in these circumstances, for the buying department to keep such accumulation of correspondence out of the general files and in their own separate binders or folders until everything has finally been delivered, and the transaction is complete, when the whole mass can be relegated to the correspondence files for the entire business.

The Emergency Order.

Hitherto it has been assumed that, in all instances, the proper formalities have been complied with when ordering. But the methods and systems of the purchasing department, however complete and essential, however ably carried out, must on occasion be swept aside so that an order can be got out without a moment's delay to meet some unforeseen need. Some important article may have been forgotten by one of the producing departments; a stores clerk may have overlooked the necessity to re-order a batch of tools; a breakdown in the power-house may call for a steel casting at once. There is no time to haggle over prices; no time to send out inquiries; the order must be rushed through at once. It may be telephoned or telegraphed or cabled or delivered verbally. But however it may have been sent, to save time, it is essential that it should later be recorded in the proper way. The first step is to send the official order, confirming whatever arrangement may have been made. Sometimes a price will have been arranged—if so, it should appear on the confirmation. If not, a letter should accompany the official order asking the supplier to send an official notification of the price at which it is being entered. The reply enables the invoice clerk to check the invoice with assurance. Past records will enable the buyer to tell whether the figure he is asked to pay is exorbitant or not. He must expect to pay more for exceptionally quick delivery; but this does not mean that he should pay ridiculously. This is another of those instances that show the value of up-to-date price records.

Contracts.

Contracts are treated in very much the same way as orders. In the legal sense, any agreement between buyer and seller, even when purely verbal, has the force of a contract. But in the commercial sense, a contract is an agreement to buy and sell, set down on paper, and signed by both buyer and seller. There are so many different sorts of contracts that in a mere article it would be impossible to give anything approaching a comprehensive account of their details and diversity. As a general rule, they are made out on special forms provided by the seller of the merchandise concerned, and the seal of the buying company (if it is a company in the legal sense) is affixed. Broadly speaking, contract forms set out the character of the goods with which they are concerned, the price, the terms of delivery and payment, any special conditions, the specification with which the goods must comply, any inspection required, and the points on which the supplier must offer guarantees to the purchaser. These are usually the standard clauses regarding conformity of the goods to the stipulated requirements; agreement to pay carriage costs, to secure the buyer against any infringement of patents or trade-marks on the supplier's part, to bear the cost of any actions caused by such infringement, and so forth. Next appear the exact quantity or number of goods covered by the contract, the exact period of time covered, and any after-service (*i.e.*, inspection or maintenance over a certain period after the installation or delivery of the goods) terms and conditions. According to the character of the contract, there may be clauses fixing maximum and minimum quantities, dates of delivery, penalties due for failure to deliver to time, and whatever other special arrangements are rendered desirable or necessary by the character of the materials and the circumstances of the contract. It is generally preferable to obtain settlement of disputes outside the law courts by means of arbitration, and a clause providing for this is embodied usually in the contract acceptance note.

Company Meeting.

English Electric Company, Limited.—The ninth ordinary general meeting of the English Electric Company, Limited, was held on Monday, at the Connaught Rooms, Great Queen Street, W.C., Mr. W. L. Hichens (chairman of the company) presiding. He pointed out, in the course of his remarks, that in the last four years, and through the Power and Traction Finance Company and other associated companies, important foreign orders had been brought to this country. Contracts amounting to over £8,000,000 sterling had been secured and financed, resulting in expenditure of more than half that sum in Great Britain. Their Company was associated with big schemes in Poland, in Greece, in Hungary, in the Sudan and in Egypt, which were the result of well-conceived schemes and of difficult negotiations that had been conducted with great skill. Those instances served to show that the English Electric Company had progressed steadily in efficiency and prestige during the period of its existence. This was further confirmed by the fact that the first important contract placed by the Central Electricity Board—namely, that for some of the 132,000-volt transformers of the electric grid which was to extend, in due course, throughout the country—had been divided among three leading firms, of which the English Electric Company was one. Another encouraging feature was that there were indications of a revival in the electrical industry. It might be short-lived, but at any rate the orders booked by the Company during the first three months of this year were nearly double in value those booked during the corresponding period of last year.

XUM

Trade Talk.

The transfer office of Messrs. Burnell & Company, Limited, has been removed to Ellesmere Port, near Birkenhead.

The imports of foreign iron ore at the Prince of Wales' dock at Workington for April amounted to 7,400 tons, compared with 7,800 tons for March.

On account of the better demand for West Coast hematite pig-iron, two furnaces at Ulverston, where stocks have been disposed of, were relighted this week.

The annual meeting of the Welsh Divisional Council of the Iron and Steel Trades Confederation was held at the Gower Hall, Swansea, on Saturday. The proceedings were private.

As the lease of the London office of Messrs. Hopkinson, Limited, Huddersfield, expires in June, they have taken new premises, more accessible and with show windows, at 34, Norfolk Street, Strand.

The furnaces at Netherton, once known as Pearsons, but in recent years acquired by Baldwins and then sold, are in the hands of the dismantlers, the material having been purchased by a well-known Sheffield firm.

The members of the South Wales and Monmouthshire branch of the Institute of British Foundrymen visited the Metallurgical Department of the University College of South Wales and Monmouthshire at Cardiff last Saturday.

The Cleveland Bridge and Engineering Company, Limited, of Darlington, have received from the Port of London Authority an order for three pairs of dock gates for the Milwall Docks, and about 800 tons of steel will be used in their construction.

The directors of Pease & Partners have decided to re-open the Ayton ironstone mines, which have been closed since August last, in order to supply the company's Tees ironworks, where one furnace is to be transferred from hematite to Cleveland iron.

Mr. John A. Smeeton, managing director of John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1., announces that his Company have decided to give up, as and from May 5, the British Agency of the Demag A.G., of Duisburg, Germany, which they have held for four years.

At the second annual general meeting of Morris Motors (1926), Limited, which was held at Cowley, Oxford, last Saturday, Mr. W. R. Morris (the chairman and managing director of the company) said that among the developments which had been arranged was the building of a modern foundry at Coventry, with a view to reducing production costs still further.

It is reported from the Clyde that nineteen vessels of 28,434 tons gross were launched in April, as against twenty-one ships of 33,700 tons in April last year. The productivity for the four months of the year comprises sixty craft, aggregating 196,300 tons, more than double that for the corresponding period last year. There is some concern regarding the scarcity of new contracts.

Lavino (London), Limited, of 48, Fenchurch Street, E.C.3, have taken up the sole sale in this country of Bavarian Graphite produced by the Graphitwerk Kropfmuehl A.-G., Munich. This graphite is suitable for all purposes, and has the advantage of being about 25 per cent. lighter than the Ceylon material. It is available in flake, fine powder and dust forms in a number of grades containing between 25 per cent. carbon and 91 per cent. carbon.

Messrs. Bolckow, Vaughan & Company, Limited, are supplying 5,582 tons of steel rails, fishplates, and sleepers for the Benguella Railway Company, Limited. They have also received an order for 880 tons of rails, weighing 115 lbs. per yd., for the Great Indian Peninsular Railway. This is the heaviest section of rail which has been supplied for use on the Great Indian Peninsular Railway. Some of the rails will be of chrome steel and others of ordinary steel sorbitically treated.

The English Electric Company, Limited, have secured two important contracts, the first being to supply the West Ham Corporation with a steam-turbine-driven electric generator set of 30,000 kw., whilst the second is for the construction of a 25,000-kw. steam-turbine and alternator for the Leicester Corporation. Both these machines will run at 3,000 r.p.m. The two contracts, which include condensing plant in both cases, and at Leicester switchgear also, have a total value of about £200,000.

Mr. James C. Bishop and Mr. Owen Coyle, joint secretaries of the Board of Conciliation for the regulation of wages in the pig-iron trade of Scotland, have received intimation from Messrs. Kerr, MacLeod & Macfarlan, chartered accountants, Glasgow, that the latter firm have examined the employers' books for the first quarter of 1928, and certified that the average net selling price is £3 12s. 1d. This means that there will be a decrease in the wages of the workmen of 2 per cent. on basis rates.

One of the three furnaces at Millom ironworks has been damped down, leaving two in blast.

At the meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle recently, the result of the ballot for the election of president and officers for the session 1928-29 was as follows:—President, Mr. Maurice S. Gibb; re-elected Vice-Presidents, Messrs. Hugh Laing and T. E. Thirlaway; ordinary members of Council, Messrs. E. L. Champness, J. Teasdale, Maxwell Ballard, and W. A. Woodeson; Hon. Treasurer, Robert H. Winstanley. The chief business was a lecture by Dr. H. S. Long, of Siemens Bros. & Co., Ltd., on wireless telegraphic direction finding for marine purposes.

Messrs. Robert Stephenson & Company, Darlington, have secured a contract to supply the Argentine Railway with ten large engines and tenders and ten spare boilers for the same class of engines. The ten engines are to be of the 2—8—2 type, with double-bogie tenders, the (light) weight being 110 tons each and total weight in working order 153 tons. Messrs. Stephenson & Company have just completed an order for ten engines for the same Railway Company, and the new contract is really in the nature of a repeat order, though certain improvements will be included.

Recent contracts received by the Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, include an Ajax-Northrup high-frequency furnace for melting one ton of steel per hour from leading French steel-makers, who are already using a smaller unit of this melting equipment. Other important contracts recently concluded are for several Ajax-Wyatt furnaces for brass-melting at the well-known Renault motor works in France. In Great Britain during the last two months contracts have been undertaken for Ajax-Northrup high-frequency furnaces for Birmingham, Sheffield, London and Braintree, while repeat orders for Ajax-Wyatt furnaces have been received from Birmingham brass monufacturers. A pair of furnaces of 240-kw. capacity for the heat treatment of aluminium alloys have just been completed at Coventry.

A contract for a new main 42-in. bore and 5¾ miles long for the Liverpool Corporation waterworks has been placed with Messrs. Stewarts & Lloyds. The main will be composed of steel tubes $\frac{7}{16}$-in. thick and 25-ft. long, with spigot-and-socket joints for lead and yarn. For protection against external corrosion the tubes will be coated with bituminous solution and wrapped in hessian cloth saturated with bituminous solution, as has been the standard practice for many years. The internal protection does not depend on the usual coating of bituminous solution, but is assured by a lining of special bituminous composition applied centrifugally in accordance with Messrs. Stewarts & Lloyds' patented process. This process results in a dense impervious coating of any thickness desired, which has a smooth glossy surface and can withstand even tropical temperatures without creeping or being impaired in efficiency as a protection against corrosion.

Personal.

Sir G. Rowland Blades, M.P., chairman of the Federation of British Industries, has been appointed a director of the Southern Railway.

Sir Robert Hadfield, Bart., has been elected a Foreign Associate of the National Academy of Sciences, Washington, D.C., an honour held by only 10 other living Englishmen. The National Academy of Sciences has 225 living members, all of them distinguished in some department of science, and is in many ways the equivalent in the United States of the Royal Society.

Mr. F. H. Rosencrants, B.Sc., Engineering Director of International Combustion, Limited, Africa House, Kingsway, London, W.C., who has recently been out to Central and South America in connection with "Lopulco" Pulverised Fuel interests, arrived back in England on May 2. He indicates that there is a good deal of activity in connection with power station development throughout Latin America, and that considerable expansion may be expected to take place within the very near future.

Wills.

Macfarlane, J. W., engineer, late of Cathcart, personal estate in Great Britain ... £30,054

Darwin, Mr. Sidney, of Ravencliff, Watt Lane, Ranmoor, Sheffield, late a partner in Messrs. Allen & Darwin, cutlery and electro-plate manufacturers £20,727

Pratten, Mr. William, Mornington, Derryvolgie Avenne, Belfast, late managing director of Messrs. Harland & Wolff, shipbuilders (personal estate in England) £62,206

Contracts Open.

Birmingham, May 16.—Supplying and laying 5½ miles of extra-high-tension cable, for the Birmingham Tame and Rea Drainage Board. Mr. H. C. Whitehead, engineer to the Board, Rookery Park, Erdington, Birmingham.

Cairo, June 16.—Supply and erection of a 300-h.p. Diesel driven engine direct coupled to a 250-k.v.a. alternator, for the Ministry of the Interior, Egypt. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. B.X. 4,349.)

Copenhagen, May 15.—Two gas pumps, for the Copenhagen Lighting Department. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 6,187.)

Johannesburg, June 7.—Three 4-ton electrically-driven portal jib cranes complete, and two 15-ton electrically-driven portal jib cranes complete, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 6,206.)

Southampton, May 29.—Supply, erection, etc., of:—(1) 15,000-kw. turbo-alternator set, complete with condensing plant; (2) 2,000-kw. rotary converter set, complete with transformer, starting panel, etc.; (3) E.H.P. switch cubicles, control panels, indicating diagrams, etc., for (1) and (2) and D.C. switchgear for (2); and (4) boiler-feed pump, for the Electricity Works, Western Esplanade, Southampton, for the Town Council. Mr. W. G. Turner, borough electrical engineer, Electricity Works, Southampton. (Fee £2 2s. for each section, returnable; additional copies £1 1s. each, non-returnable.)

Troyan, May 30.—Supply and erection of pipe lines, hydraulic turbines, generators, switchgear and accessories, for the Troyan Water Syndicate, Troyan. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. B.X. 4,378.)

Reports and Dividends.

Coventry Chain Company, Limited.—Interim dividend of 3 per cent. on ordinary.

Whessoe Foundry & Engineering Company, Limited.—Dividend of 12½ per cent., less tax, for the year.

Stanton Ironworks Company, Limited.—Preference dividend at the rate of 6 per cent. per annum for the half-year ended March 31.

Fairbairn, Lawson, Combe, Barbour, Limited.—Debit balance of £55,726 for 1927, increasing the adverse balance brought forward to £101,557.

Brush Electrical Engineering Company, Limited.—Dividend 10 per cent.; surplus, £10,763, of which £8,941 will be distributed under co-partnership scheme.

Monk Bridge Iron & Steel Company, Limited.—Debit of profit and loss account brought forward, £145,744; profit for year ended December 31, £3,553; debit balance to carried forward, £142,191.

Johnson & Phillips, Limited.—Net profit for the year 1927 was £108,858; brought forward, £82,475; final dividend of 5 per cent. on ordinary, making 10 per cent. for the year; carried forward, £85,072.

Union Steel Corporation (of South Africa), Limited.—Net profit, £5,729; balance of £82,525 unappropriated at the end of last year; transfer to a reserve for bounty on pig-iron included in accounts for year ended December 31, 1926, £16,850; written off iron-ore options and expenditure on prospecting, £1,168; carried forward, £70,235.

New Companies.

Maurice Newbould & Partners, Limited.—Capital £100. Ironfounders, etc. Directors: H. F. Wightman-Mountain, Caxton House, Westminster, S.W.1; M. Newbould, S. Lingwood, and E. H. Aldridge.

British Neidig Pumps.—Capital £100 in £1 shares. Agreement with Fr. August Neidig in Mannheim and C. A. Harnden, Limited, of Hyde, near Manchester, and G. W. Thornton & Company, Limited, of Manchester, for the manufacture in England of Neidig pumps and other productions of the Neidig Machine Works in Mannheim.

The Board of Trade have referred to the Standing Committee an application for the marking, with an indication of origin, of imported spring balances of all descriptions. The date of the Committee's public inquiry will be announced later, and communications should be addressed to the Secretary, Mr. E. W. Reardon, Board of Trade, Great George Street, London, S.W.1, as early as possible and, in any case, not later than May 25, 1928.

"SERVICE GRC FIRST"

ALL YOUR NEEDS IN REFRACTORIES AND MINERALS CAN BE AMPLY FILLED BY

The General Refractories Co. Ltd.

SHEFFIELD.

Enquiries are cordially invited and will be promptly and courteously answered. Expert technical advice on Refractological matters is offered free.

SANDS — GANISTER — FIREBRICKS — SILICAS — MAGNESITES — COROMA & CHROME BRICKS — FIRE CEMENTS—CORE BINDERS—COMPOSITIONS

ETC.

MONOMARK:

BCM / REFRACTORY LONDON.

Telegrams: Refractory, Sheffield. *Telephone: 22311 Sheffield.*

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The outlook in the Cleveland iron market, estimated from the amount of business being transacted at present, is by no means so favourable as had been confidently anticipated, and although smelters have now no difficulty in disposing of current outputs, the much-desired all-round expansion has not yet materialised, either as regards home or export trade. There is, however, a somewhat better demand for the foundry trades. Scotland has been buying much more freely, and the April shipments of pig-iron from the Tees to Scotland have been the best for nearly two years. But the English foundries are only buying sparingly, and there is no indication whatever of any better export demand for Cleveland iron. Current quotations, both to home and foreign consumers, are still uniform at the following levels :—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d.

The low prices now current for East Coast hematite have had the salutary effect of attracting a few orders from South Wales for export, which will help to diminish stocks, but a further reduction in makers' quotations is still regarded by consumers as essential to renewed activity in markets. The current nominal quotation for mixed numbers is, however, unchanged at 70s. per ton, with a concession of a shilling per ton on orders of any magnitude. On the North-West Coast prices have a firmer tendency. Bessemer mixed numbers ruling steady at 70s. per ton at works.

LANCASHIRE.—Demand for foundry pig by local consumers continues on the slow side, and as an inducement to buyers some of the Midland producers are offering concessions, Derbyshire No. 3 foundry being quoted round 72s. per ton, with Staffordshire brands at 6d. to 1s. per ton for delivery Manchester or equal. Some small parcels of Scotch brands have also changed hands at from 87s. 6d. to 90s., also including delivery.

THE MIDLANDS.—At Birmingham this week buyers of foundry pig were again in a minority and business generally was dull and uneventful, with few forward dealings reported. Quotations rule about as follow :—Derbyshire No. 3, 63s. to 63s. 6d. at furnaces, and Northamptonshire No. 3, 57s. 6d. to 58s., f.o.t.; North Staffs No. 3, 63s. to 63s. 6d.; Cleveland No. 3, 81s. 9d., and Lincolnshire No. 3, 72s. 6d., delivered this area.

SCOTLAND.—The market for foundry pig in this locality remains exceedingly quiet, and very little business is passing. Almost without exception the founders are complaining of lack of work, and many of them are unable to find orders to keep them going for a full week. The light castings section and the pipe founders are carrying large stocks of manufactured material, and are forced to curtail their output to prevent further increase of stocks. There is no change to report in the prices, which remain on the basis of 70s. for No. 3 foundry at the furnaces.

Finished Iron.

The improvement in the demand for marked Staffordshire bars at £12 basis is slow. Makers are, however, fairly well engaged. The position with regard to crown and nut and bolt iron continues very bad, and makers are not able to procure sufficient business to keep the mills regularly employed. Quotations for crown bars vary widely, and from Lancashire this iron is offered at £9, delivered. Staffordshire works quote any figure from £9 5s. to £10. Nut and bolt iron quotations are anything from £8 15s. to £9 5s., delivered. Continental works are securing fair business in the Darlaston area for No. 3 iron, for which they are quoting £6 2s. 6d. to £6 5s., delivered.

Steel.

Although, of course, there is now a substantial tonnage of steel material of various kinds in course of production, market operations continue on a moderate scale. At Sheffield, however, there is a reasonably good buying of Siemens acid billets, the quotation for which is unaltered at £10, but basic billet sales are slower. Soft qualities are £6 5s., and hard from £7 2s. 6d. to £7 12s. 6d. There is heavy competition in soft wire rods, which are quoted at £7 10s. High-speed steel is 2s. 9d. per lb., 18 per cent. tungsten, and 2s. per lb. for 14 per cent. tungsten. Production of open-hearth steel is nothing like up to capacity, and producers are experiencing difficulty in keeping active the furnaces which are operating. Crucible steel and electric steel output is smaller than of late. Motor steel production is a good feature, and makers of special steels are busy. The tinplate market maintains a firm tone, the majority of the works being well booked up to the end of August and asking higher prices for early delivery. Prices for I.C. 20 x 14 x 112 sheets are from 18s. 3d. to 18s. 6d.

Scrap.

Dealings in foundry scrap metals of late have been usually on the small side, but here and there may be noted a slightly more active tendency in buying than has been experienced for some months past. In the Midlands, for example, there is a good demand for cast-iron scrap and for heavy machinery scrap broken into cupola sizes; 67s. 6d. per ton delivered is offered, and 53s. per ton delivered for light cast-iron scrap. At Middlesbrough there is a steady market for heavy cast iron, ordinary grades selling at 62s. per ton and machinery quality in handy pieces at 66s. In Scotland it is rather difficult to dispose of heavy machinery cast-iron scrap suitable for foundries at 68s. 6d. to 70s. Heavy ordinary cast-iron scrap to the same specification is quoted at 65s., cast-iron scrap is 60s., and old cast-iron railway chairs are 68s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—With consumptive demand at home and abroad maintained at a steady average, fluctuations in values of warrant copper vary within narrow compass from day to day, and as at present production of the metal is under controlled conditions, any violent market changes may be regarded as unlikely in the near future. In many quarters it is confidently expected that this year's consumption figures will show considerable expansion over those for last year if the present state of affairs continues.

Closing quotations are :—

Cash.—Thursday, £61 8s. 9d. to £61 10s.; Friday, £61 8s. 9d. to £61 10s.; Monday, £61 7s. 6d. to £61 10s.; Tuesday, £61 8s. 9d. to £61 10s.; Wednesday, £61 11s. 3d. to £61 12s. 6d.

Three Months.—Thursday, £61 15s. to £61 16s. 3d.; Friday, £61 15s. to £61 16s. 3d.; Monday, £61 12s. 6d. to £61 15s.; Tuesday, £61 13s. 9d.; to £61 15s.; Wednesday, £61 16s. 3d. to £61 17s. 6d.

Tin.—Market sentiment as regards the position of tin has developed a slight tendency to improvement, and rather more outside interest has been in evidence of late. But for professional activities, values would possibly have reached higher levels by this time. The recent expansion of demand from the tinplate works in South Wales and a fair average of inquiries on American and Continental account are, of course, bull points to be considered, and, with the issue of last month's official returns, it is quite anticipated that quotations may early acquire an upward impetus.

Official closing prices :—

Cash.—Thursday, £232 15s. to £233; Friday, £232 10s. to £233 15s.; Monday, £232 15s. to £233; Tuesday, £232 to £232 5s.; Wednesday, £233 to £233 2s. 6d.

Three Months. — Thursday, £231 15s. to £232; Friday, £233 to £233 5s.; Monday, £231 15s. to £232; Tuesday, £231 2s. 6d. to £231 7s. 6d.; Wednesday, £232 7s. 6d. to £232 10s.

Spelter.—In the market for ordinary spelter, the position of buyer and seller is now fairly evenly balanced, as only sufficient supplies of the metal are on offer, and there is not much inclination on the part of buyers to press for supplies. During the first three months of this year production exceeded last year's figures for the corresponding period by about 20,000 tons, and this extra tonnage does not seem to be needed by consumers at the present time, in view of the curtailed activity of the market.

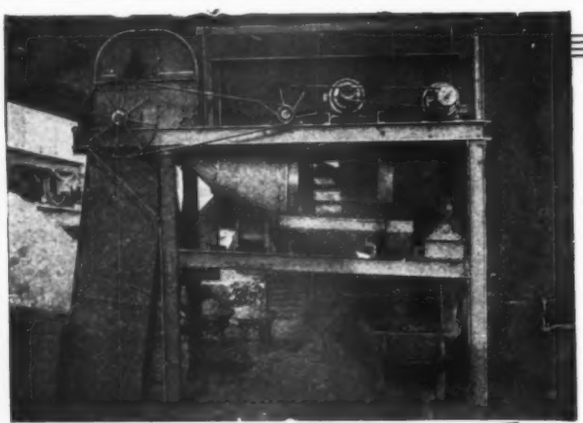
Official close :—

Ordinary.—Thursday, £26 5s.; Friday, £26 6s. 3d.; Monday, £26 6s. 3d.; Tuesday, £26 6s. 3d.; Wednesday, £26 7s. 6d.

Lead.—As regards soft foreign pig, production is maintained at a level which would seem to be in excess of demand, and the possibility of the output being decreased at all seems very remote, in view of the improvements which have been reported in several consuming centres. Fluctuations have been frequent of late in the rate of demand, the general opinion now being that buyers are satisfactorily placed for current requirements and are in no need to enter the market in search of further supplies at present.

Closing prices :—

Soft Foreign (Prompt).—Thursday, £20 11s. 3d.; Friday, £20 7s. 6d.; Monday, £20 6s. 3d.; Tuesday, £20 3s. 9d.; Wednesday, £20 5s.



TYPES AND SIZES TO SUIT
ALL FOUNDRY REQUIREMENTS

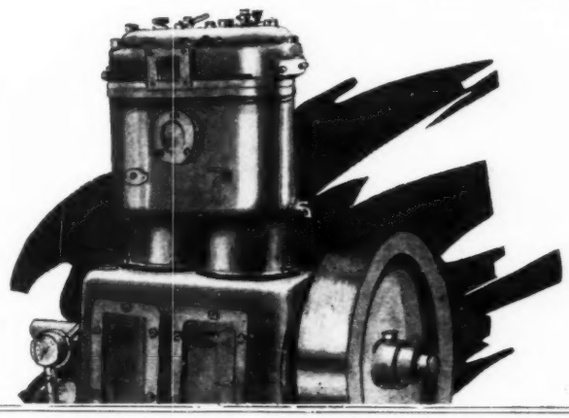
A Revelation to
IRONFOUNDERS!

The "RAPID" Patent Self-Contained
Combined Sand Sifter and Electro
Magnetic Separator Equipment.

Practically no Iron Losses.
It Saves as it Sieves as it Separates.
Recovers Brads, Splashings, Fettlings, Gits, &c.

RAPID MAGNETTING MACHINE Co., Ltd.
LOMBARD STREET, BIRMINGHAM
Let Your Problems be Our Pleasure.

WHAT THE BRADLEY SERVICE MEANS TO THE FOUNDRYMAN. No. 3.



A SELECTION OF STOCKS AVAILABLE FOR HIGH DUTY CASTINGS

Bradley's maintain a big selection of stocks of Refined Pig Irons suitable for almost every class of high-duty castings. The ironfounder who finds it necessary to quickly make up a mixture for a purpose outside the usual run of his work will find the Bradley Service of incalculable value in giving him just what he wants—quickly, easily and with absolute certainty of success. Two typical selections from the Bradley range, which are always stocked ready for immediate delivery.

Type B.A.		Type C.C.	
T.C.	3.0/3.2	T.C.	2.9/3.1
Si	.9/1.1	Si	1.75/2.0
S	.09/.11	S	.07/.09
P	.3/.45	P	.60/.80
Mg	.60/.80	Mg	1.0/1.25
FOR HYDRAULIC CYLINDERS.		FOR ARTIFICIAL SILK MACHINERY ROLLERS	

Quick deliveries can always be made and local deliveries of 1 ton lots and upwards will be delivered by lorry within a matter of hours only.

Bradley's

PIG IRON

"A QUALITY FOR EVERY REQUIREMENT"

Make full use of The Bradley Service

Write or 'phone for particulars of the Bradley range of Refined Pig Irons. Immediate attention is given to all enquiries and the knowledge and long experience of Bradley's is at the disposal of all foundrymen.

BRADLEY & FOSTER Ltd. BF DARLASTON, STAFFS.

WEEKLY PRICE CURRENT.

COPPER

	£ s. d.
Standard cash	61 11 3
Three months	61 16 3
Electrolytic	66 10 0
Tough	64 0 0
Best selected	64 5 0
Sheets	92 0 0
India	75 0 0
Wire bars	66 15 0
Do. May	66 15 0
Do. June	66 15 0
Ingot bars	66 15 0
H.C. Wire rods	71 10 0
Off. av. cash, April	61 14 1 11/20
Do. 3 mths., April	61 16 2 1/20
Do., Sttlmnt., April	61 14 0 19/20
Do., Electro, April	66 15 0
Do., B.S., April	65 0 0
Aver. spot price, copper, Apr.	61 14 1¼
Do., Wire bars, April	67 0 0
Solid drawn tubes	13d.
Brazed tubes	13d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	233 0 0
Three months	232 7 6
English	239 0 0
Bars	240 0 0
Straits	236 10 0
Australian	234 10 0
Eastern	233 5 0
Banca	Nominal
Off. av. cash, April	234 6 0 1/20
Do., 3 mths., April	234 10 7 7/20
Do., Sttlmt., April	234 6 6 1/20
Aver. spot, April	234 6 0½

SPELTER.

	£ s. d.
Ordinary	26 7 6
Remelted	25 5 0
Hard	20 10 0
Electro 99.9	30 5 0
English	26 17 6
India	21 15 0
Zinc dust	33 0 0
Zinc ashes	8 0 0
Off. aver., April	25 8 1 3/20
Aver., spot, April	25 9 10½

LEAD.

	£ s. d.
Soft foreign ppt.	20 5 0
English	21 15 0
Off. average, April	20 8 8 1/20
Average spot, April	20 6 1½

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	33 15 0
Do. V.M. ex whf.	32 0 0
Rods	39 0 0
Boiler plates	29 10 0
Battery plates	31 5 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	58 0 0
Chinese	42 0 0
Crude	36 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 2 6
45/50%	£13 2 6
75%	£20 10 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	4/4 lb.
Ferro-titanium—	
23/25%, carbonless	1/2
Ferro-phosphorus, 20/25%	£17 10 0
Ferro-tungsten—	
80/85%, c. fr.	1/3½ lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£32 17 6
4/6% car.	£22 7 6
6/8% car.	£22 2 6
8/10% car.	£22 0 0
Ferro-chrome—	
Max. 2% car.	£34 17 6
Max. 1% car	£39 10 0
Max. 0.70% car	£45 17 6
70% carbonless	1/2 lb
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 10 0
76/80%, packed	£14 10 0
76/80%, export	£13 5 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	3 7 6
Bundled steel and shrngs.	2 19 0 to 3 2 6
Mixed iron and steel	3 0 0
Heavy cast iron	3 0 0
Good machinery for foundries	3 5 0
Cleveland—	
Heavy steel	2 17 0
Steel turnings	2 8 6
Cast iron borings	2 3 0
Heavy forge	3 10 0
Bushelled scrap	3 2 6
Cast-iron scrap	3 2 0 to 3 6 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6
London—Merchants' buying prices delivered yard.	
Copper (clean)	52 0 0
Brass (clean)	38 0 0
Lead (less usual draft)	18 0 0
Tea lead	15 10 0
Zinc	15 10 0
New aluminium cuttings	75 0 0
Braziery copper	47 0 0
Gunmetal	48 0 0
Hollow pewter	165 0 0
Shaped black pewter	125 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	82/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	57/6
,, No. 3 fdry.	63/6
Shrops. basic	—
,, Cold blast, ord.*	155/-
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3	58/-
Derbyshire forge	60/-
,, fdry. No. 3	63/6
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	70/-
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3	68/6
Lincs. forge	65/6
,, fdry. No. 3	66/6
E.C. hematite	82/6
W.C. hematite	85/-
Lincs. (at furnaces)—	
Forge No. 4	61/-
Foundry No. 3	62/-
Basic	60/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	72/6
Northants foundry No. 3	58/-
Dalzell, No. 3	100/- to 102/6
Summerlee, No. 3	87/6 to 94/-
Glengarnock, No. 3	87/6 to 94/-
Gartsherrie, No. 3	87/6 to 94/-
Monkland, No. 3	87/6 to 94/-
Coltness, No. 3	87/6 to 94/-
Shotts, No. 3	87/6 to 94/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.) nom.	9 0 0 to 10 10 0	
Angles	—	
Tees to 3 united ins.	—	
Nut and bolt iron	8 17 6	
Hoops	12 0 0	
Marked bars (Staffs.) f.o.t.	12 0 0	
Gas strip	11 10 0	
Bolts and nuts, ¾ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 7 6 to 8 12 6	
Boiler plts.	10 10 0	
Chequer plts.	10 5 0	
Angles	7 17 6	
Tees	8 17 6	
Joists	7 17 6	
Rounds and squares, 3 in. to 5½ in.	7 10 0	
Rounds under 3 in. to ¾ in. (Untested)	7 15 0 and upwards	
Flats, over 5 in. wide and up	8 17 6	
Flats, 5 in. to 1½ in.	7 17 6	
Rails, heavy	8 2 6 to 8 10 0	
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	9 17 6	
Galv. cor. shts., 24g.	13 2 6	
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	£6 0 0 to 6 10 0	
Billets, hard	£7 2 6 to 7 12 6	
Sheet bars	£5 15 0 to 5 17 6	
Tin bars	£5 12 6 to 5 15 0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	16.00
Basic	18.76
Bessemer	19.26
Malleable	19.01
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	44.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.65
Sheets, blue an'l'd., 9 and 10	2.00
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	13/9
Other Districts, foundry	—
,, ,, furnace (basis)	12/- to 13/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/3
,,	28×20	,,	36/6
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/-
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 9
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63½%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
May 3 ..	61 8 9	dec. 2/6
,, 4 ..	61 8 9	No change
,, 7 ..	61 7 6	dec. 1/3
,, 8 ..	61 8 9	inc. 1/3
,, 9 ..	61 11 3	,, 2/6

Electrolytic Copper.

	£ s. d.	
May 3 ..	66 10 0	No change
,, 4 ..	66 10 0	,, ,,
,, 7 ..	66 10 0	,, ,,
,, 8 ..	66 10 0	,, ,,
,, 9 ..	66 10 0	,, ,,

Standard Tin (cash).

	£ s. d.	
May 3 ..	232 15 0	inc. 27/6
,, 4 ..	233 10 0	,, 15/-
,, 7 ..	232 15 0	dec. 15/-
,, 8 ..	232 0 0	,, 15/-
,, 9 ..	233 0 0	inc. 20/-

Tin (English ingots).

	£ s. d.	
May 3 ..	238 15 0	inc. 25/-
,, 4 ..	239 15 0	,, 20/-
,, 7 ..	238 15 0	dec. 20/-
,, 8 ..	238 0 0	,, 15/-
,, 9 ..	239 0 0	inc. 20/-

Zinc Sheets (English)

	£ s. d.	
May 3 ..	33 10 0	No change
,, 4 ..	33 15 0	inc. 5/-
,, 7 ..	33 15 0	No change
,, 8 ..	33 15 0	,, ,,
,, 9 ..	33 15 0	,, ,,

Spelter (ordinary).

	£ s. d.	
May 3 ..	26 5 0	inc. 2/6
,, 4 ..	26 6 3	,, 1/3
,, 7 ..	26 6 3	No change
,, 8 ..	26 6 3	,, ,,
,, 9 ..	26 7 6	inc. 1/3

Lead (English).

	£ s. d.	
May 3 ..	22 0 0	inc. 5/-
,, 4 ..	22 0 0	No change
,, 7 ..	22 0 0	,, ,,
,, 8 ..	21 15 0	dec. 5/-
,, 9 ..	21 15 0	No change

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 1	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7½
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	86 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	91 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 0	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	—	—	—	—	—	—	—	—	65 4½

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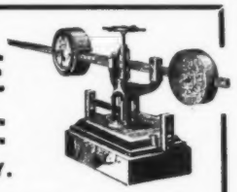

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